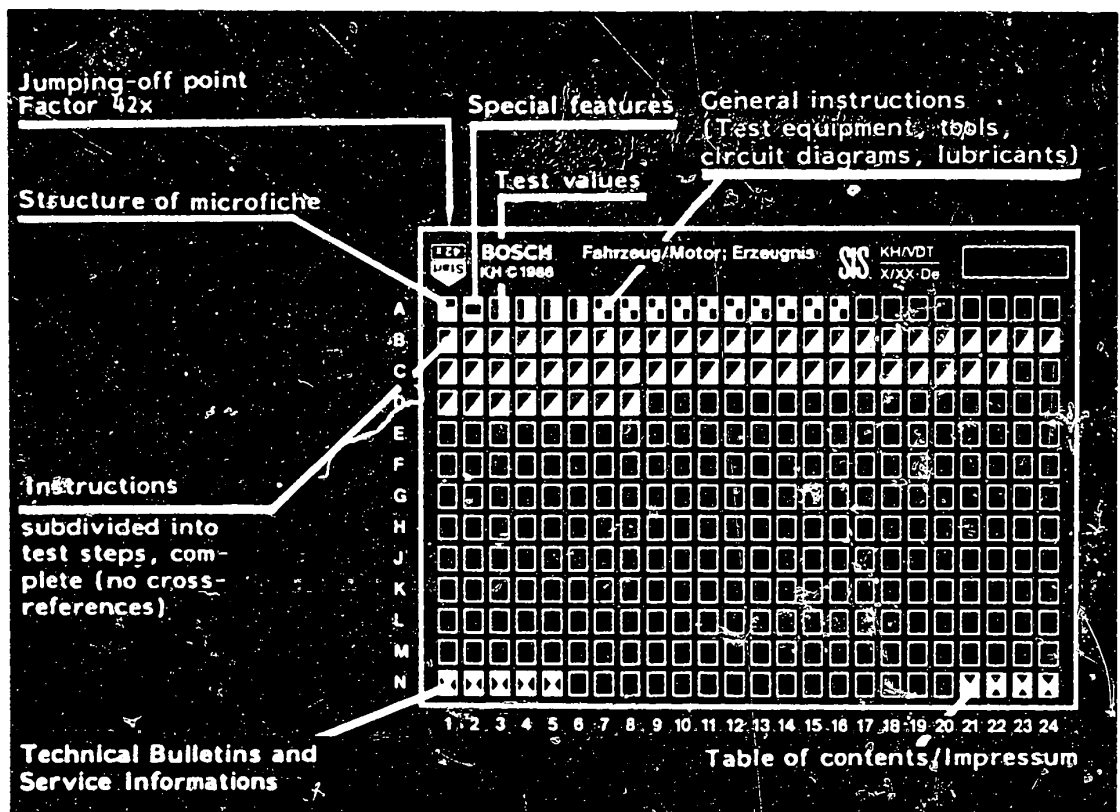


## Structure of microfiche



1. Read from left to right
2. Title of microfiche (appears on each coordinate)

<b>E16</b>	Product/component/test step
	Vehicle/engine

Coordinate

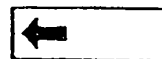
3. Limits of section



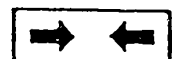
Beginning



Mid-section



End



One-page section

4. Purely vehicle-specific passages in the text are marked with a vertical bar.

5. Reference to relevant working steps in the test specifications, e.g. coordinate C6.

**C6**

**A1**

Repair and testing



## 1. Special features

The following models of starting motor (DM, DW) are dealt with:

0 001 108 ..	12 V	1.4 kW
110 ..	12 V	1.7 kW
111 ..	24 V	1.6 kW
112 ..	12 V	0.9 kW
113 ..	12 V	0.8 kW
114 ..	12 V	1.0 kW



## 2. Test specifications - electrical

Note: Permanently excited 12 V starting motors DW, DM must not be operated on 24 V. Armature would be rotated at overspeed. This might lead to the cracking-open of the stator frame and to the flinging-out of parts of the armature.

Part no.	Model	No load			<b>C14</b>	Short circuit									<b>C17</b>	<b>C13</b>	
						2x143Ah in parallel with 10 Ω resistor (EFAL 152, 153 term. 30/2) Torque 1)			1x143Ah with 10 m Ω resistor Torque 1)			2x143 Ah in series with 10 m Ω series resistor Torque 1)					
		V	<A	>min <sup>-1</sup>	V	A	> Nm	V	A	> Nm	V	A	> Nm	V			
0 001 106...	DW 1.4 kW (1.1 kW)	11.5	75	2900	3.5	475 - 600	12.5	3.2	430 - 550	11.5				3)	8		
					4.5	625 - 800	16.0	4.2	580 - 750	15.0				4)	7.3		
0 001 110...	DW 1.7 kW	11.2	95	2800	3.8	650 - 840	17.5	3.5	600 - 790	17.0				3)	8		
					3.0	510 - 660	14.0	2.7	460 - 610	13.5				4)	7.3		
0 001 111...	DW 24V 1.6 kW	23	40	2800							12	450 - 550	25.0				
											14	550 - 650	28.0		18		
0 001 112...	DM 0.9 kW	11.5	45	5500				5.7	350 - 450	7.0				3)	8		
								6.7	400 - 500	8.0				4)	7.3		
0 001 113...	DM 0.8 kW	11.5	45	5000				5.7	350 - 450	6.0				3)	8		
								6.7	400 - 500	7.0				4)	7.3		
0 001 114...	DM 1.0 kW	11.5	50	5000				5.2	400 - 500	7.5				3)	8		
								6.2	450 - 550	8.5				4)	7.3		

1) Only for test benches with torque tester

2) Minimum pull-in voltage for solenoid switch in case of tooth/tooth connection (pinion extension travel max. 2 mm).

3) Test specification for switch 0 331 303 505, .. 563

4) Test specification for switch 0 331 302 553, .. 559

**A3**

Test specifications - electrical

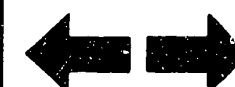
DM/DW starting motors



**A4**

Test specifications - electrical

DM/DW starting motors



### 3. Test specifications - mechanical

	<b>B 15</b>		<b>B 20</b>		<b>B 17</b>		<b>C 6</b>	<b>C 11</b>	<b>C 2</b>	<b>C 15</b>	<b>C 16</b>
Part no.	Commutator diameter		Carbon brushes		True-running error		Armature longitudinal play mm	Armature braking torque Nm	Overrunning torque Nm	Backlash mm	Pinion clearance mm
	new mm	min. mm	Length new mm	Usable length mm	Commutator mm	Laminated core mm					
0 001 108..	32.3	31.2	12.5	8	0.01	0.05	0.05 - 0.4	0.9 - 1.4	0.12 - 0.18	0.3 - 0.6	2.0 - 3.0
0 001 110..	32.3	31.2	14	8	0.01	0.05	0.05 - 0.4	0.9 - 1.5	0.12 - 0.18	0.3 - 0.6	2.0 - 3.0
0 001 111..	32.3	31.2	12.5	8	0.01	0.05	0.05 - 0.4	0.9 - 1.4	0.12 - 0.18	0.3 - 0.6	2.0 - 3.0
0 001 112..	35.0	33.5	11	8	0.02	0.05	0.05 - 0.4	0.3 - 0.4	0.12 - 0.18	0.3 - 0.6	2.0 - 3.0
0 001 113..	35.0	33.5	11	8	0.02	0.05	0.05 - 0.4	0.3 - 0.4	0.12 - 0.18	0.3 - 0.6	2.0 - 3.0
0 001 114..	35.0	33.5	11	8	0.02	0.05	0.05 - 0.4	0.3 - 0.4	0.12 - 0.18	0.3 - 0.6	2.0 - 3.0

**A5**

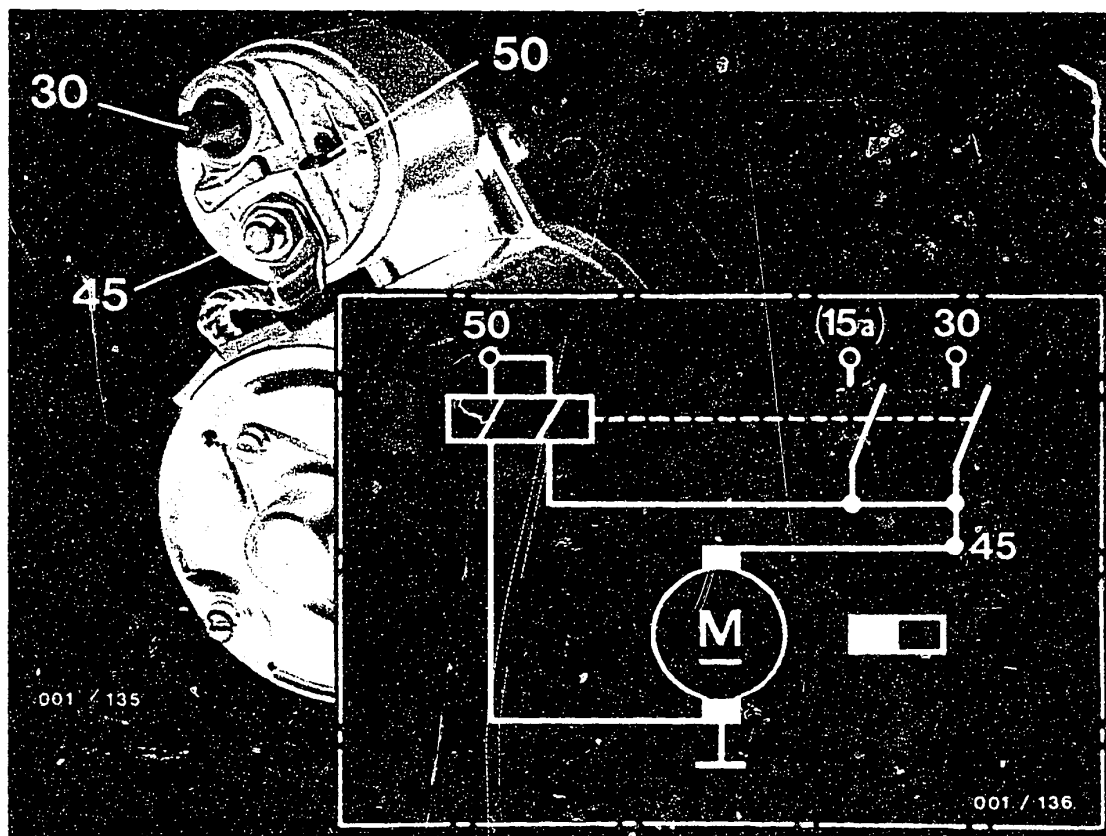
Test specifications - mechanical  
DM/DW starting motors


**A6**

Test specifications - mechanical  
DM/DW starting motors







1 = Permanent magnets

2 = Solenoid switch

#### 4. Connection diagram, circuit diagram, terminal designations

Term. 15 a present in some cases.

**A7**

Circuit diagram

DM/DW starting motors



## 5. General information

- 5.1 The lubricants specified in this manual must be used in order to guarantee proper operation.
- 5.2 Professional repair work can only be performed using specified tools and accurate measuring instruments. We therefore recommend that only the stated tools be used.
- 5.3 The sintered bushings in the drive-end-bearing housing, commutator end shield, planetary-gear carrier (DW) and pinion must always be replaced whenever repairs are carried out.
- 5.4 Due to their special design as compared with conventional versions of starting motor, DM/DW starting motors are sensitive to shock, impact and pressure. They may therefore be clamped only by the flange (not by the stator frame).

### Exception:

Testing with starting-motor test bench EFAL 152, EFAL 153.

### Note:

Do not incorrectly connect starting motor during electrical test.

(Housing to ground, + 12 V to terminal 30 on solenoid switch).



## 5.5 Cleaning the parts

Armature, ring gear, overrunning-clutch drive and relay must be cleaned only with compressed air (max. 4 bar) and a clean rag. Do not use any liquid cleaning agent.

Other parts, such as screws and armature shaft, can be washed in low-inflammability, commercially available cleaning agent.

Do not breathe in vapours.

### Caution!

Parts which have been washed must be dried thoroughly since otherwise gases may form later in the starting motor when it has been sealed - danger of explosion-like detonation.

### Observe the following safety regulations:

Decree on Working with Combustible Liquids (Vbf) issued by the Federal Ministry of Labour (BmA).

Safety Regulations for Handling Chlorinated Hydrocarbons:

for the workshop      ZH 1 / 222  
for the employee      ZH 1 / 119

issued by the Central Association of German Employers' Liability Insurance Associations (Central Association for Accident Prevention and Industrial Medicine),  
Langwartweg 103, 5300 Bonn 5.

In countries outside the Federal Republic of Germany, observe the corresponding local regulations.



## 6. Necessary test equipment and tools

Test panel		KDAW 9984
Transformer panel		KDAW 9985
Interturn-short-circuit tester		
	(EFAW 90)	0 681 103 500
or	(EFAW 95)	0 681 103 200
Electrics tester	ETE 014.000	0 684 101 400
or		
Multimeter		Commercially available
Torque wrench		Commercially available
Arbor press		Commercially available
Mounting sleeve (for 12 mm dia.)		KDAL 5028
Mounting base		KDAL 5047
Assembly tool (for brush plate)		KDAL 5048
Plug gauge 8.1 mm		KDAL 5049
Tailstock steadies for holding armature when turning down commutator		
with Morse taper 2		KDAW 9987
with Morse taper 3		KDAW 9990
Undercutting saw		KDAW 9998
Assembly tool (for brush-holder plate)		KDAL 5051



Necessary tools (continued)

Torquemeter	0.04 ... 0.12	Nm	KDAL 5482
	0.15 ... 0.8	Nm	KDAL 5485

Spring scale	2 ... 12	N	KDAW 9991
	5 ... 20	N	KDAW 9993
	15 ... 50	N	KDAW 9992

Puller

Base part	KDAL 5493
-----------	-----------

Spring collet	12.0 ... 12.5 mm dia.	KDAW 5493/0/3
---------------	-----------------------	---------------



## 7. Lubricants

### Special lubricating grease

for shafts

500 g can (VS 10832Ft) 5 932 240 150

### Silicone oil

for heavily loaded bearing points

0.50 l can (VS 13834 oil) 5 962 260 605

### Silicone grease

High-grade lubricating grease with  
high-pressure additives (Ft 2 v 3)

50 g tube

5 700 082 005

250 g tube

5 700 082 025

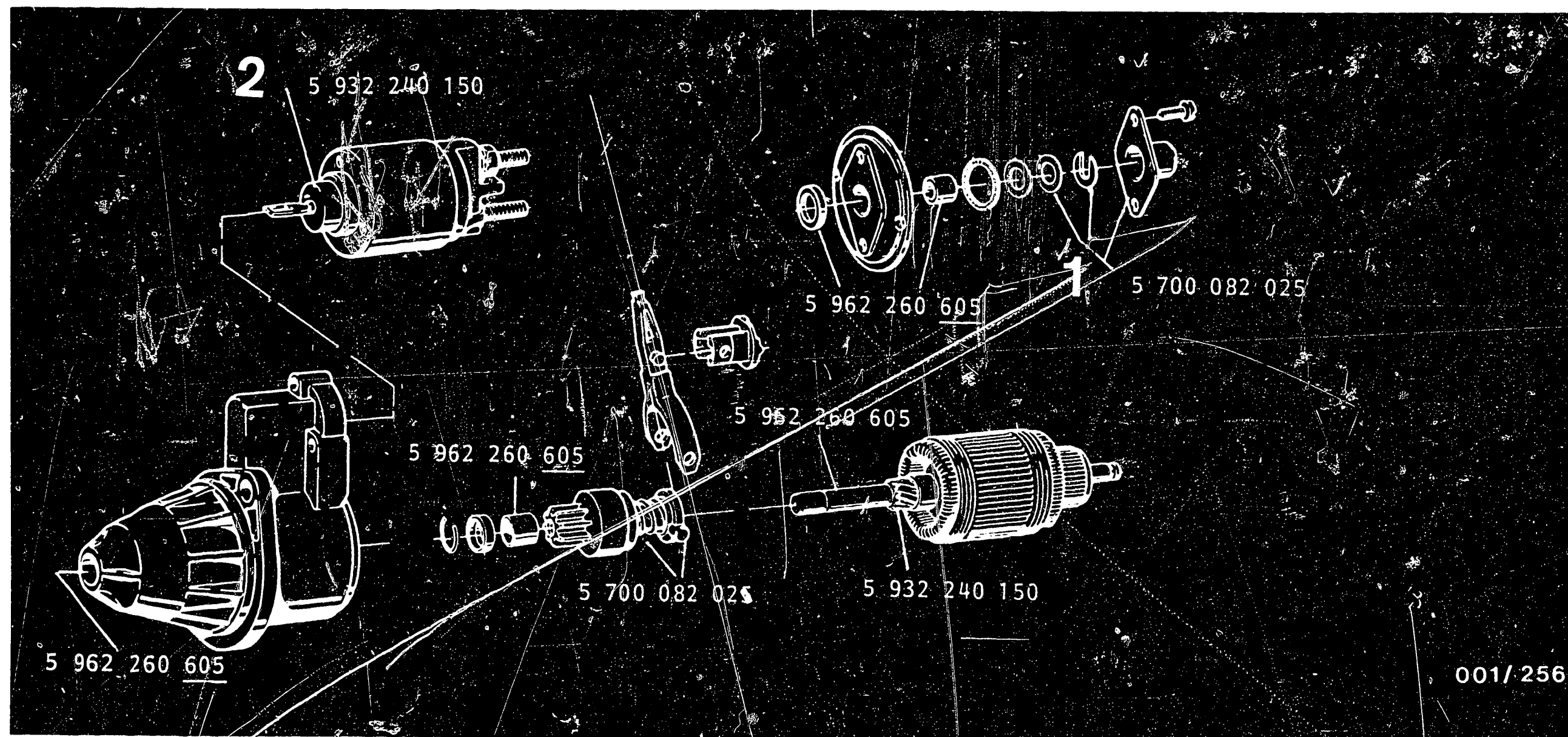
### Special lubricating grease

for planetary gear trains

(DOW corning x5-7514)

5 899 907 318





- 1 = Do not grease the inside of the holding or compensating washers or of the closure cap until after adjustment of the longitudinal play of the armature. Then grease lightly using 5 700 082 025 (approx. 0.2 g)
- 2 = 0 331 303 505 only: Grease relay armature only lightly with 5 932 240 150.

#### 7.1 Lubrication table DM starting motors

The commutator must be kept free of grease and oil.  
Grease or oil the indicated parts sparingly.  
Too much grease causes malfunctions at low temperatures.  
Lightly oil all other bare parts with anti-corrosion oil.

**A13**

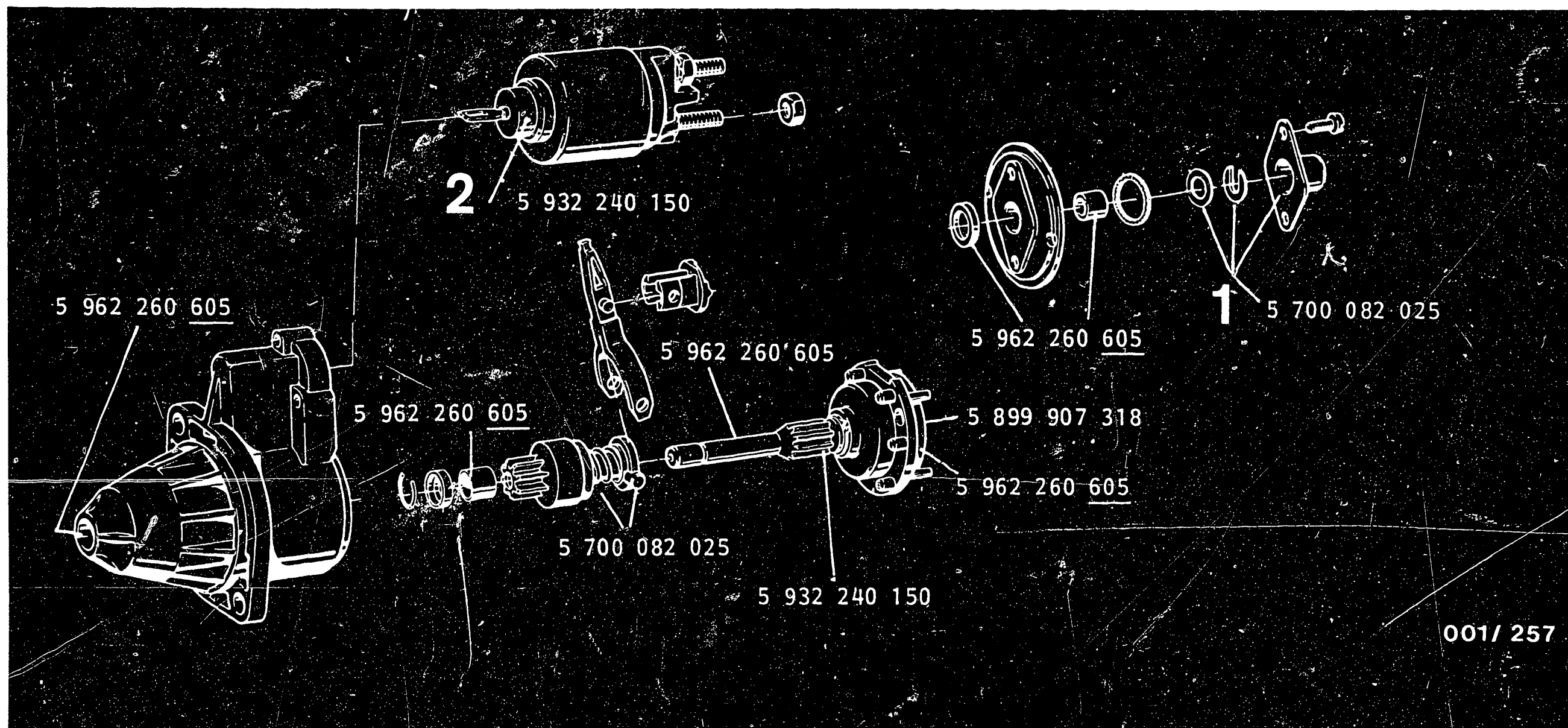
Lubrication table  
DM/DW starting motors



**A14**

Lubrication table  
DM/DW starting motors





001/ 257

- 1 = Do not grease the inside of the holding or compensating washers or of the closure cap until after adjustment of the longitudinal play of the armature. Then grease lightly using 5 700 082 025 (approx. 0.2 g)
- 2 = 0 331 303 505 only: Grease relay armature only lightly with 5 932 240 150.

#### 7.2 Lubrication table DW starting motors

The commutator must be kept free of grease and oil.  
 Grease or oil the indicated parts sparingly.  
 Too much grease causes malfunctions at low temperatures.  
 Lightly oil all other bare parts with anti-corrosion oil.

**A15**

Lubrication table  
 DM/DW starting motors

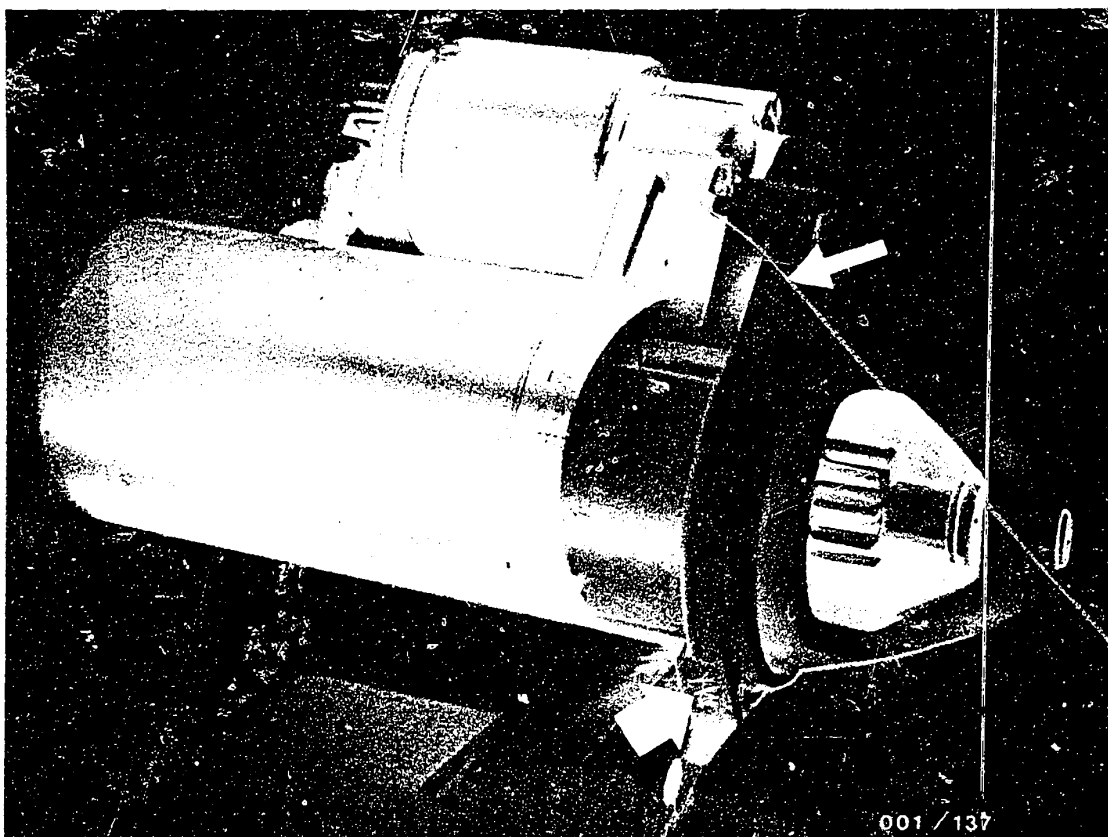


**A16**

Lubrication table  
 DM/DW starting motors







#### 8. Dismantling the starting motor

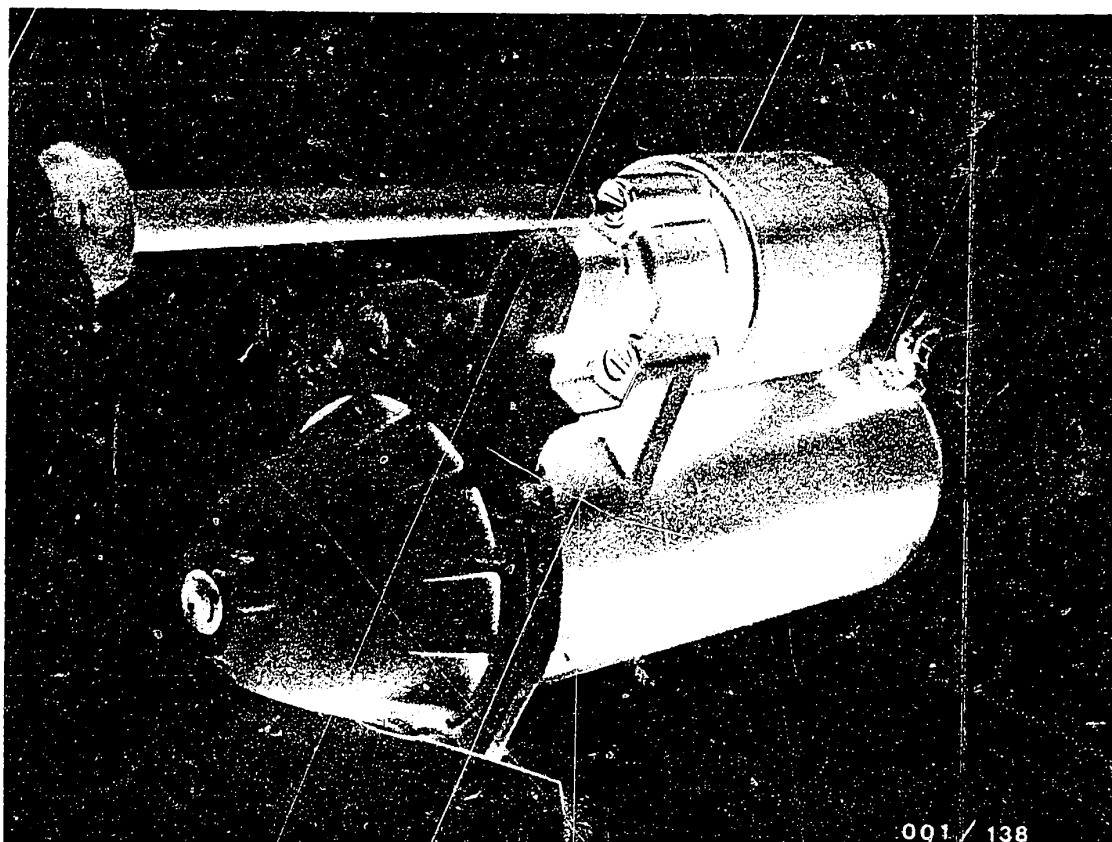
Clamp the starting motor by its "eye" (see picture).

The very thin-wall stator frame of the permanently-excited starting motor may under no circumstances be exposed to knocks (e.g. number punches) or heavy pressure (e.g. clamping in vice).

The stator frame would be deformed and would break the permanent magnets.

Number punches (e.g. repair symbols or end numbers when renewing the stator frame) must be applied to the drive-end-bearing housing (see picture, arrow).





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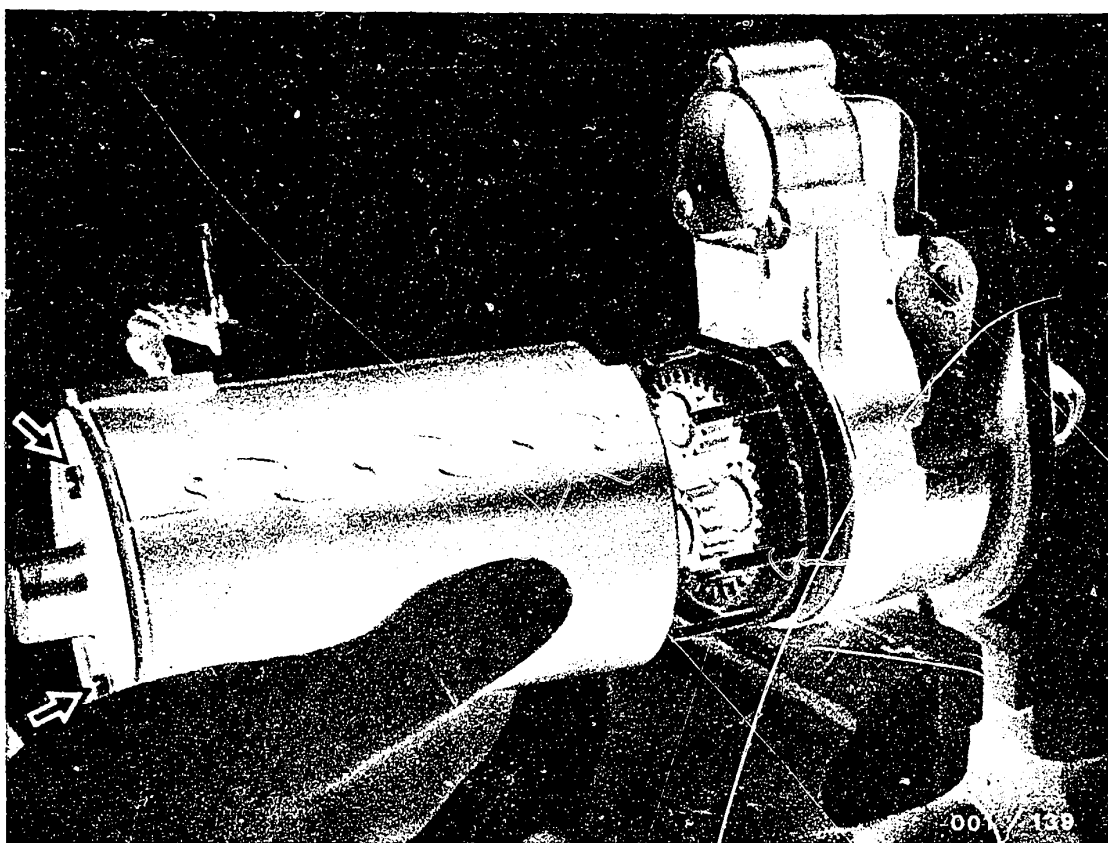
### 8.1 Removing the solenoid switch

- Unscrew term. 45 on solenoid switch.
- Loosen 3 fastening screws from solenoid switch and remove solenoid switch with armature and return spring.

**B2**

Dismantling the starting motor  
DM/DW starting motors

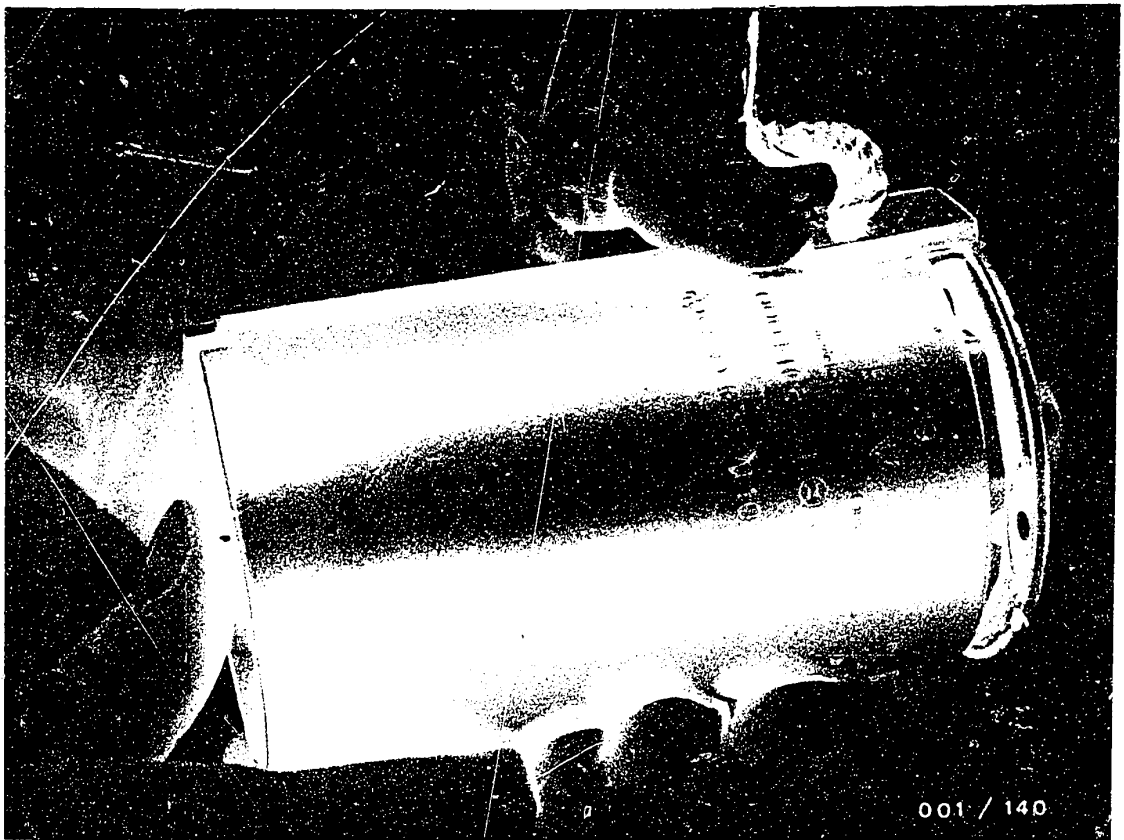




## 8.2 Removing the stator frame (DW starting motors)

- Turn the starting motor round in the vice (see picture)
- Loosen screws on rear closure cap, but do not yet remove (see arrows)
- Unscrew through-bolts
- Remove stator frame with cover plate, armature and commutator end shield.





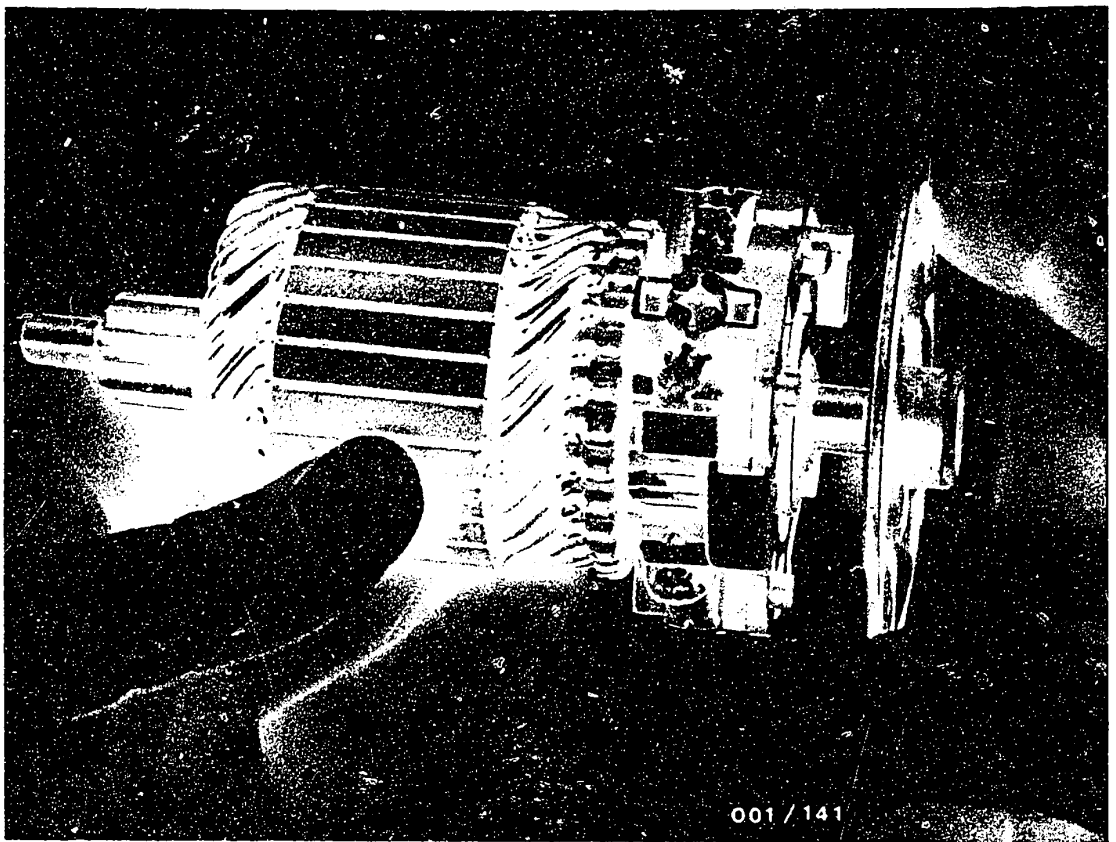
### 8.2.1 Removing the armature (DW starting motors)

Remove cover plate (on drive-end-bearing end, ring gear)

Carefully press armature with commutator end shield out of stator frame by hand.

At the same time, push out terminal 45 with sealing rubber.





Unscrew closure cap from commutator end shield.

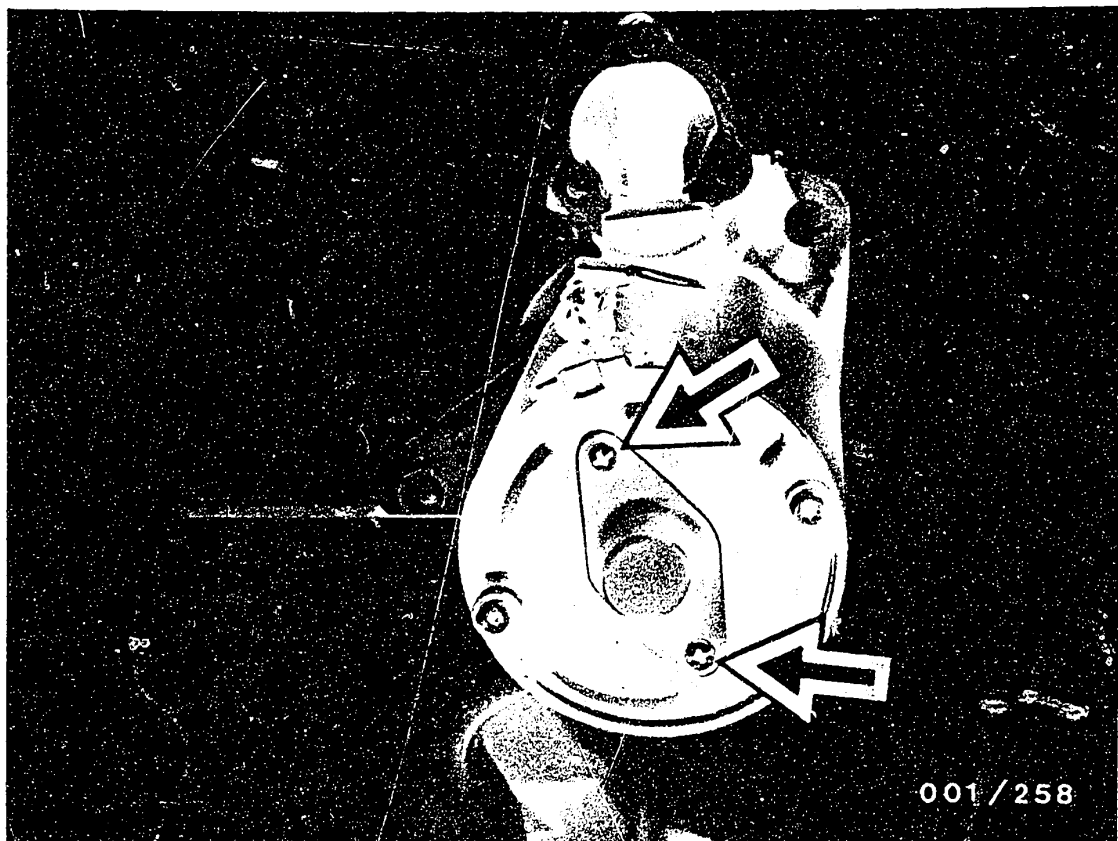
Remove holding discs and shims from armature shaft.

Remove commutator end shield.

**B5**

Dismantling the starting motor  
DM/DW starting motors

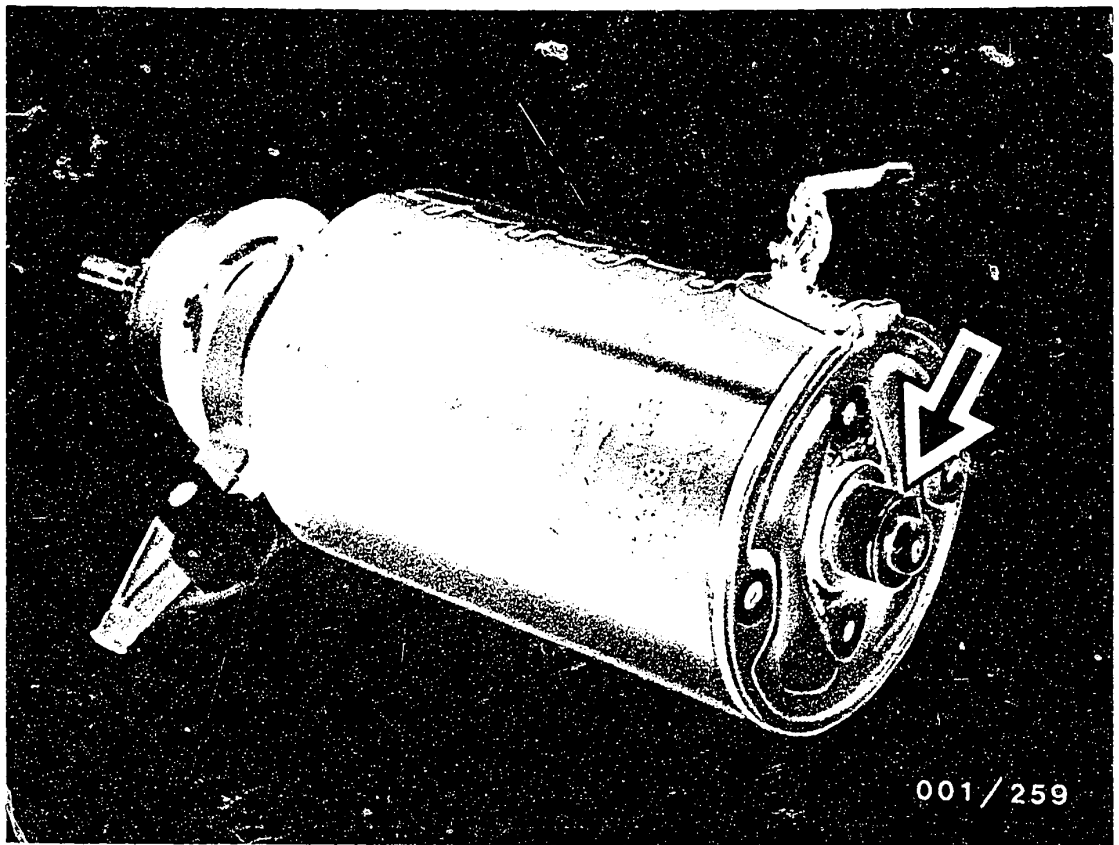




### 8.3 Removing the stator frame (DM starting motors)

- Clamp starting motor (see picture)
- Loosen screws on rear closure cap (see arrow), but do not remove at this stage
- Unscrew through-bolts
- Remove stator frame with armature, commutator end shield, intermediate bearing, fork lever and pinion with overrunning clutch.





### 8.3.1 Removing the armature (DM starting motors)

Unscrew closure cap.

Remove holding washers and shims from armature shaft (picture, arrow).

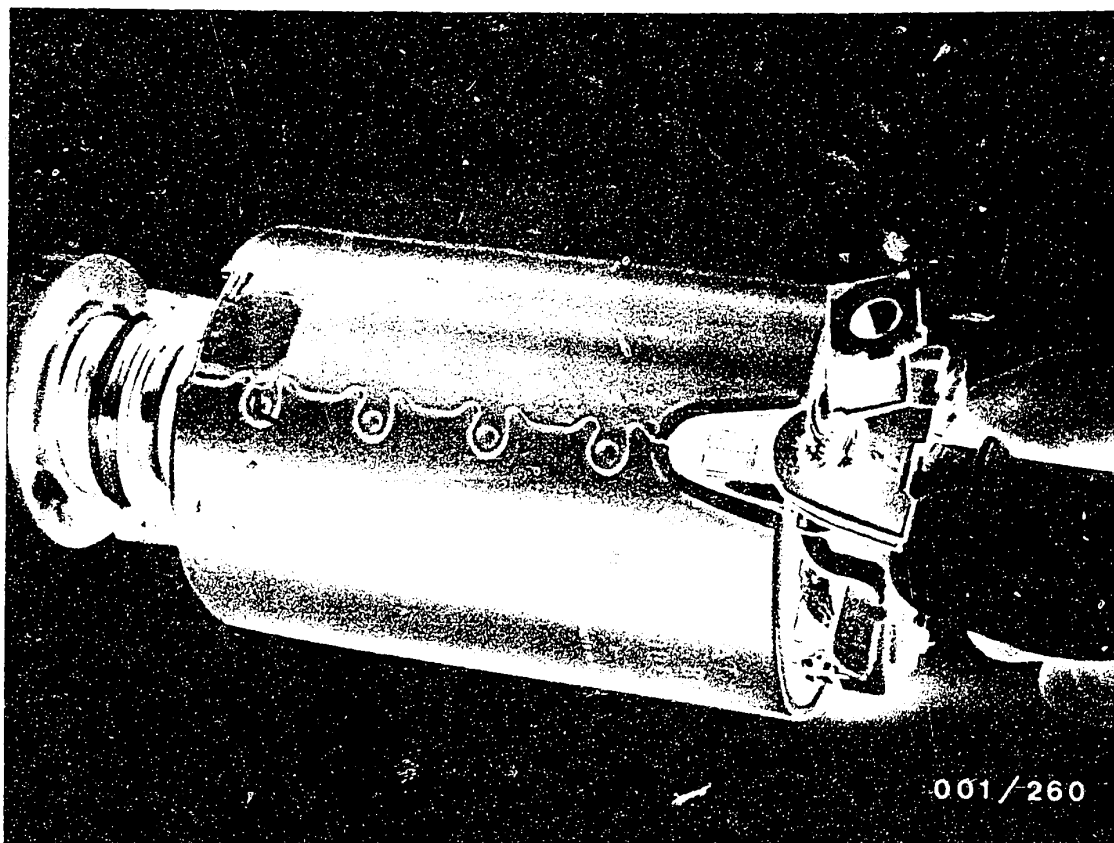
Remove commutator end shield.

**B7**

Dismantling the starting motor

DM/DW starting motors





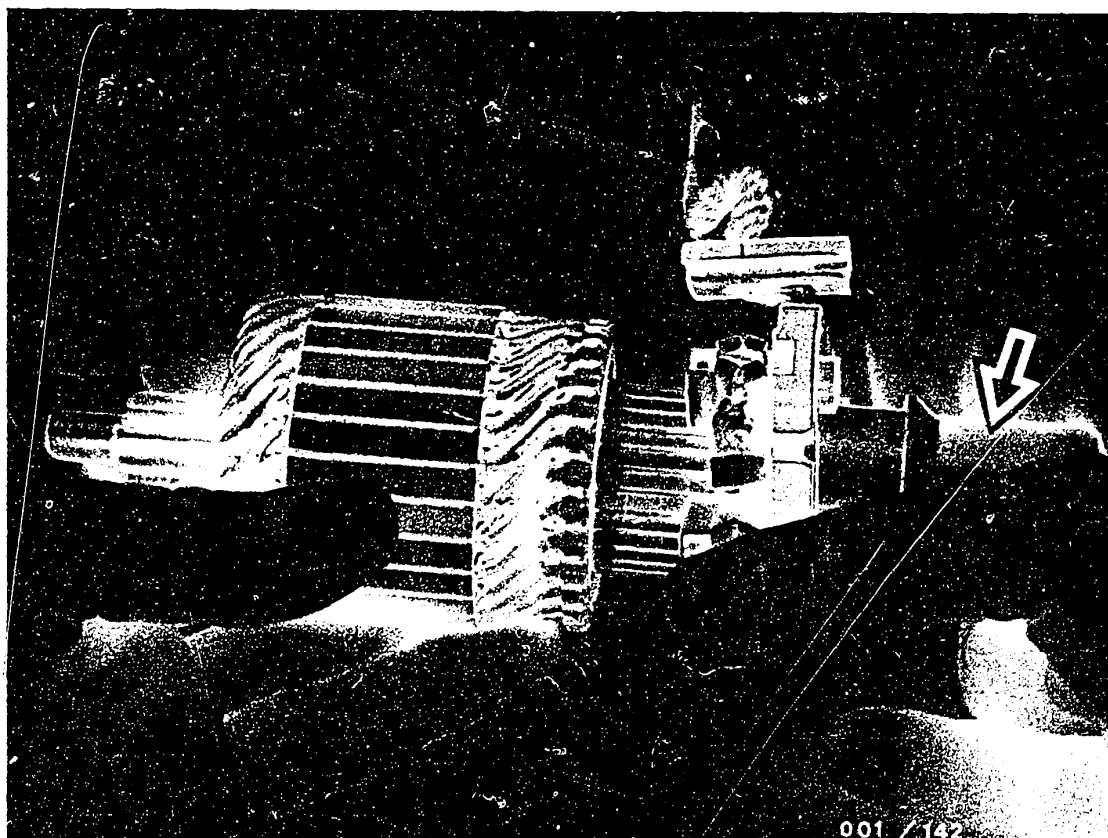
Connect assembly tool KDAL 5051 to armature shaft (see picture).

Slide brush-holder plate as far as it will go onto KDAL 5051. Pull KDAL 5051 with brush-holder plate from armature shaft and put down.

Remove armature with pinion, overrunning clutch, fork lever and intermediate bearing (0 001 114 ..) from stator frame.



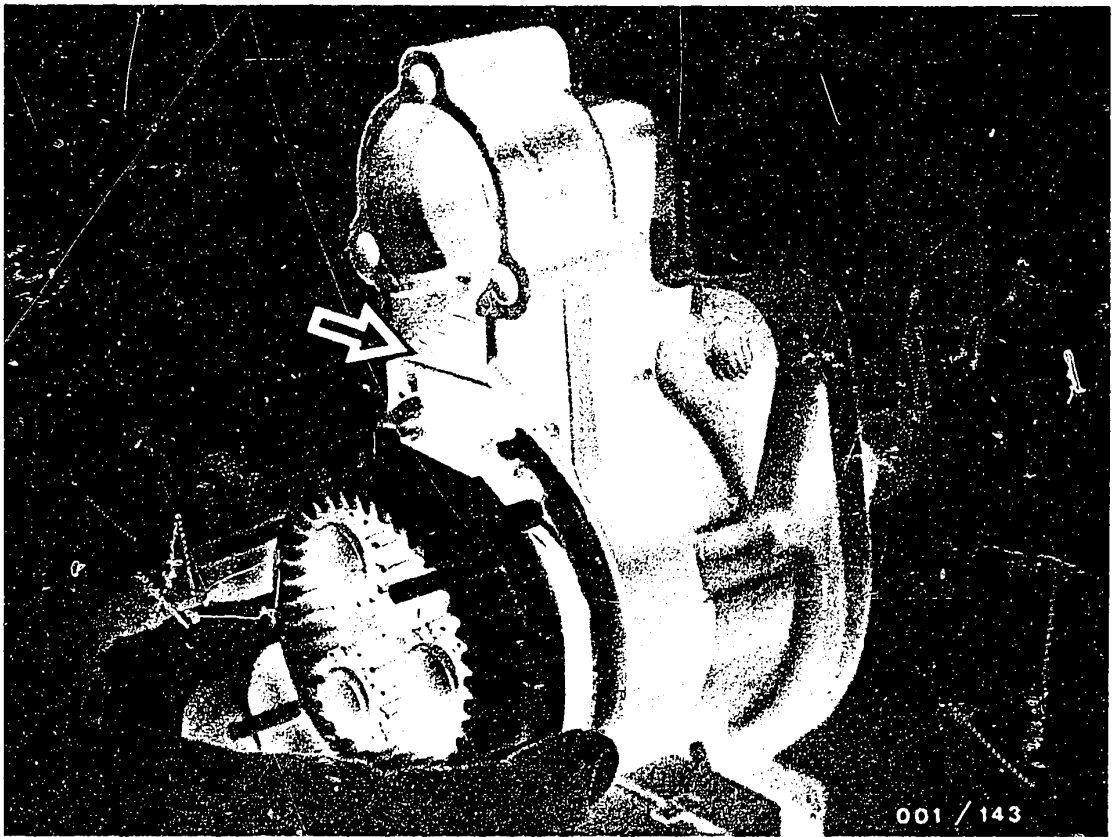




#### 8.4 Removing the brush plate (DW starting motors)

- Plug tool KDAL 5048 onto armature shaft (arrow).
- Slide brush plate as far as it will go onto KDAL 5048.
- Pull KDAL 5048 with brush plate off armature shaft and put down.

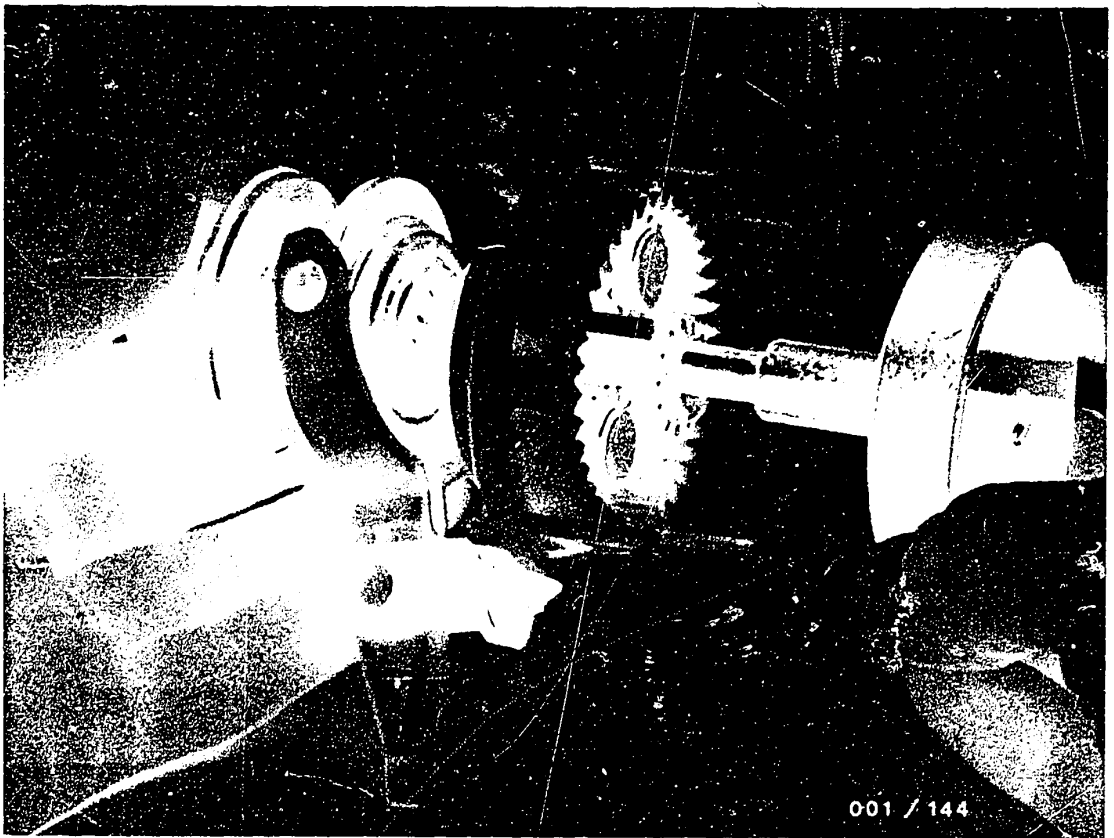




### 8.5 Removing the overrunning-clutch drive and planetary-gear train (DW starting motors)

Remove cover plate (already done in picture).

- Take off sealing rubber (see picture, arrow).
- Remove planetary-gear train with overrunning clutch and fork lever from drive-end bearing housing.

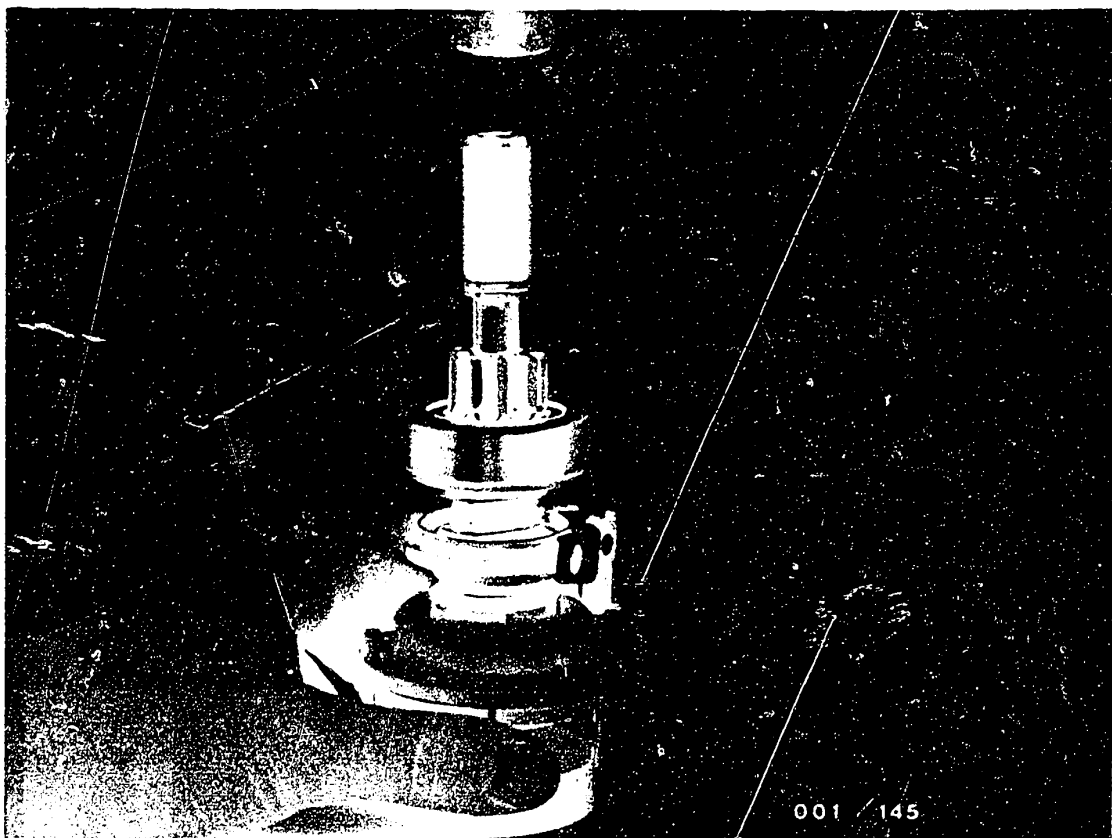


To prevent damage, plug the planetary-gear train with overrunning clutch horizontally onto mounting base (KDAL 5047) (see picture) and then place vertically.

**B11**

Dismantling the starting motor  
DM/DW starting motors





Using mounting sleeve KDAL 5028 and a rubber mallet, knock back the stop ring (picture).

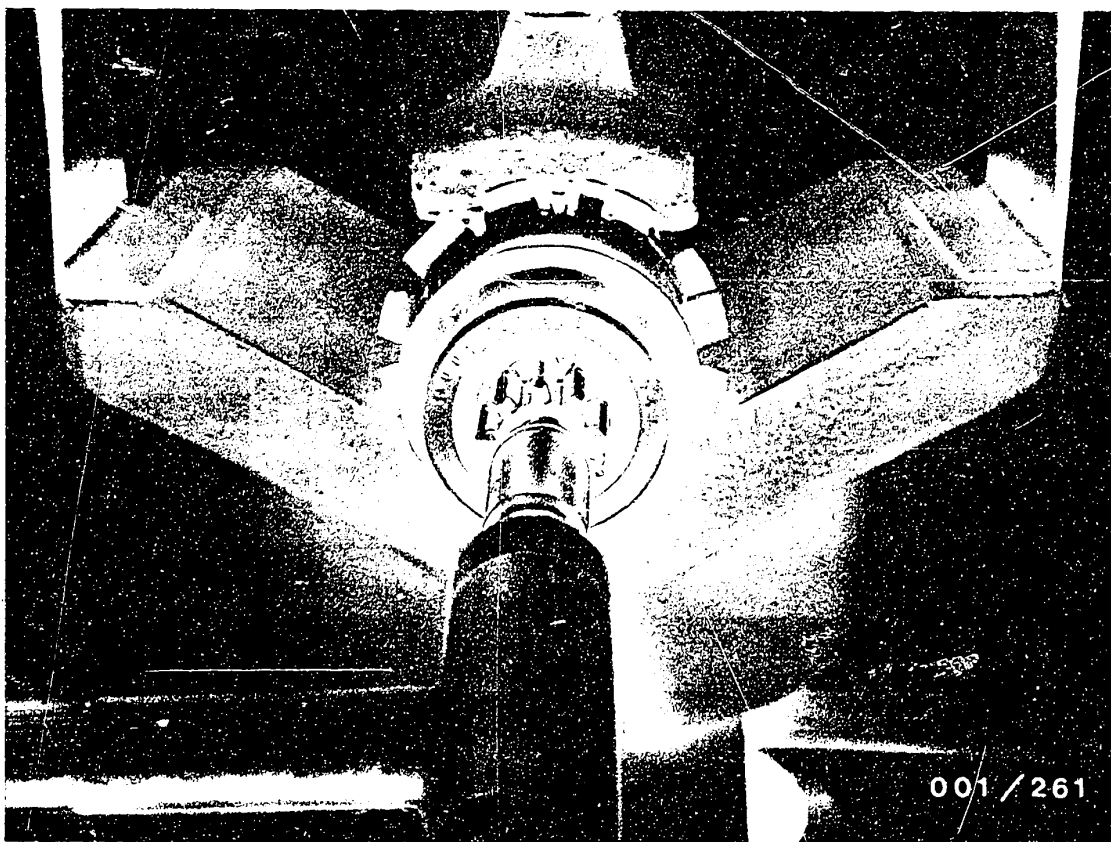
Using suitable pliers, bend the ends of the retainer wide apart.

Prevent damage to armature shaft when removing.

If necessary, carefully remove burr from armature shaft groove using smoothing file.

(Otherwise damage to drive bushing).





#### 8.5.1 Removing the armature shaft (DM starting motors)

Clamp armature in clamping support KDAW 9999.

Knock back stop ring with impact sleeve KDAL 5028 and rubber hammer (see picture).

Using suitable pliers, bend wide apart the ends of the retainer.

When removing the retainer, avoid damage to the armature shaft.

Using a fine-cut file, carefully remove any burr on the groove of the armature shaft (otherwise damage to transmission sleeve).

Remove pinion with overrunning clutch and intermediate bearing from armature shaft.



## 9. Cleaning the parts

Armature, windings, overrunning-clutch drive and relay must be cleaned only with compressed air (max. 4 bar) and a clean rag. Do not use liquid cleaning agent.

Other parts, such as screws and armature shaft, can be washed in low-inflammability, commercially available cleaning agent.

Do not breathe in vapours.

### Caution!

Parts which have been washed must be dried thoroughly since otherwise gases may form later in the starting motor when it has been sealed - danger of explosion-like detonation.

### Observe the following safety regulations:

Decree on Working with Combustible Liquids (Vbf) issued by the Federal Ministry of Labour (BmA).

Safety Regulations for Handling Chlorinated Hydrocarbons:

for the workshop      ZH 1 / 222  
for the employee      ZH 1 / 119

issued by the Central Association of German Employers' Liability Insurance Associations (Central Association for Accident Prevention and Industrial Medicine),  
Langwartweg 103, 5300 Bonn 5.

In countries outside the Federal Republic of Germany, observe the corresponding local regulations.



## Working with inflammable or health-hazardous materials

Benzine, tri- or perchloroethylene are approved for the washing of motor vehicle electric components which are to be repaired.

Handle both cleaning agents carefully according to their degree of danger.

Benzine, acetone or ethanol are combustible liquids and may cause explosion when mixed with air. Washing must be performed only in special bowls or containers with fusible lids which close automatically if the liquid ignites, thereby smothering the fire. An extractor system must be provided for larger washing vessels (as of 500 x 500 mm).

As regards starting motors, reference has already been made in earlier repair manuals to the fact that, after the parts have been washed, particularly after windings have been washed in benzine, they must be dried thoroughly.

In the case of sliding-gear starting motors, the first start after washing must be performed on the test bench without the closure cap in order to prevent detonations.



Tri and per are liquids whose vapours have a numbing effect and are hazardous to health if breathed in over long periods.

Tri vapours are heavier than air and there is, therefore, increased danger at ground level.

Wear protective goggles and gloves when washing components.

Regular or continuous cleaning operations with tri may only be performed in special containers with the extractor on.

When washing components, avoid bending over the tri container.





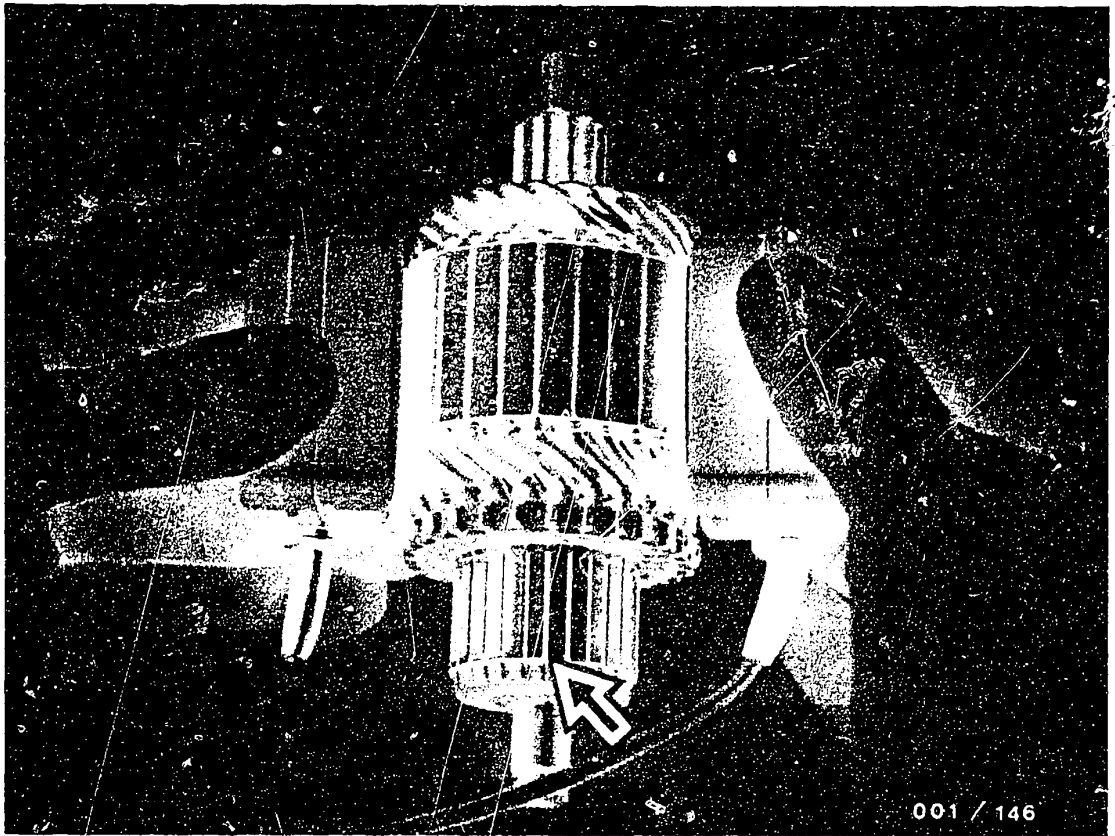
## 10. Examination and repair

### 10.1 General

Examine all parts for wear and damage. Replace worn parts.

Lubricate starting motor as per lubrication table before and during re-assembly. If necessary, lubrication points and lubricants are given in the text. In addition, complete lubrication tables are added on Coordinates A13/A14, A15/A16.





## 10.2 Examining and repairing the individual components

### Examining the armature

Check the armature for interturn short circuit with tester EFAW 90 or EFAW 95 (picture).

Test armature for short circuit to ground with test panel KDAW 9984 and transformer panel KDAW 9985.

Test voltage:        ~ 40 V up to 12 V starting motor  
                         ~ 80 V up to 24 V starting motor

Watch for any open circuit (individual laminations are black - arrow).



## Turning down and undercutting the commutator

If worn points are visible on the comutator, it must be turned down.

Heavy burns indicate an open circuit - replace the armature.

Clamp the armature at the commuatator end shield and drive-end-bearing housing ends.

Do not damage the armature shaft.

### Note:

Do not clamp the armature shaft in the centre when turning down. (Centre is used in manufacture only for pre-machining the armature shaft).

### Preturning:

We recommend the use of a carbide tool.

Turn down the commutator until the worn points are no longer visible.

Commutator minimum diameter:

0 001 108 .. 31,2 mm

110 ..

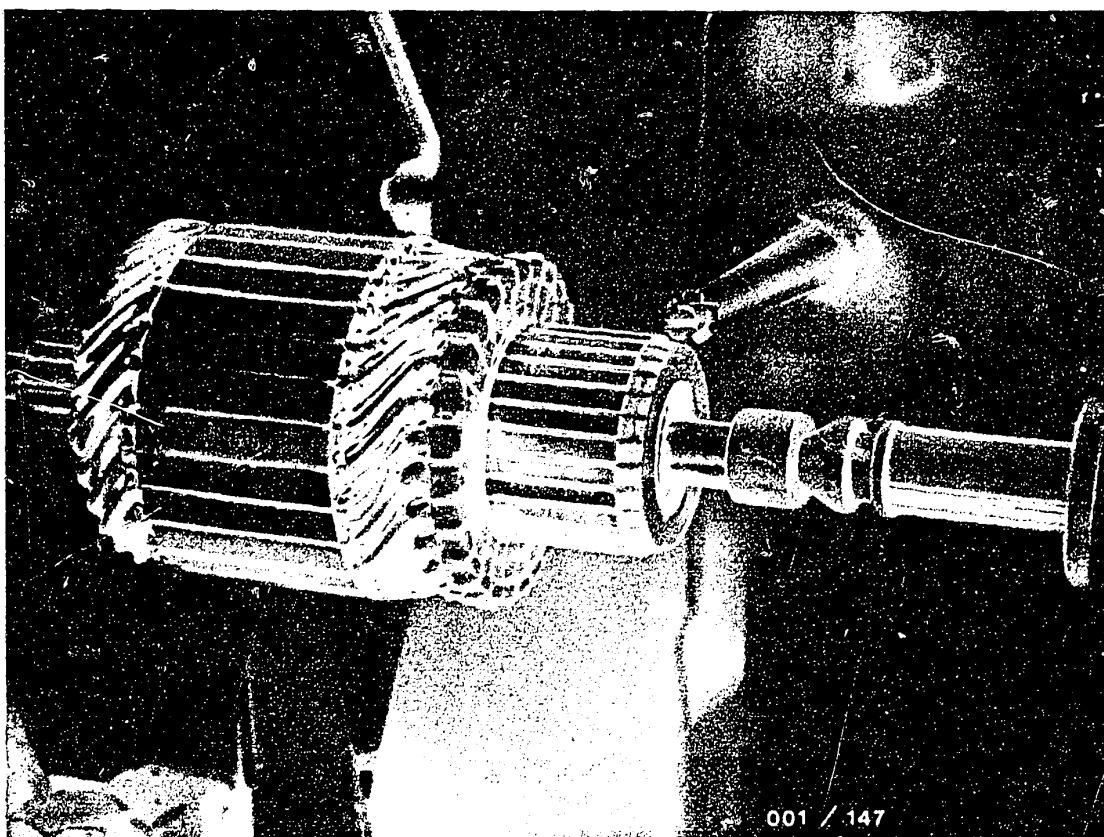
111 ..

0 001 112 .. 33,5 mm

113 ..

114 ..





### Undercutting and finish-turning the commutator

Clamp the armature in the mount of the undercutting saw KDAW 9998. Undercut the insulation between the laminations, 0.8 mm deep.

#### Note:

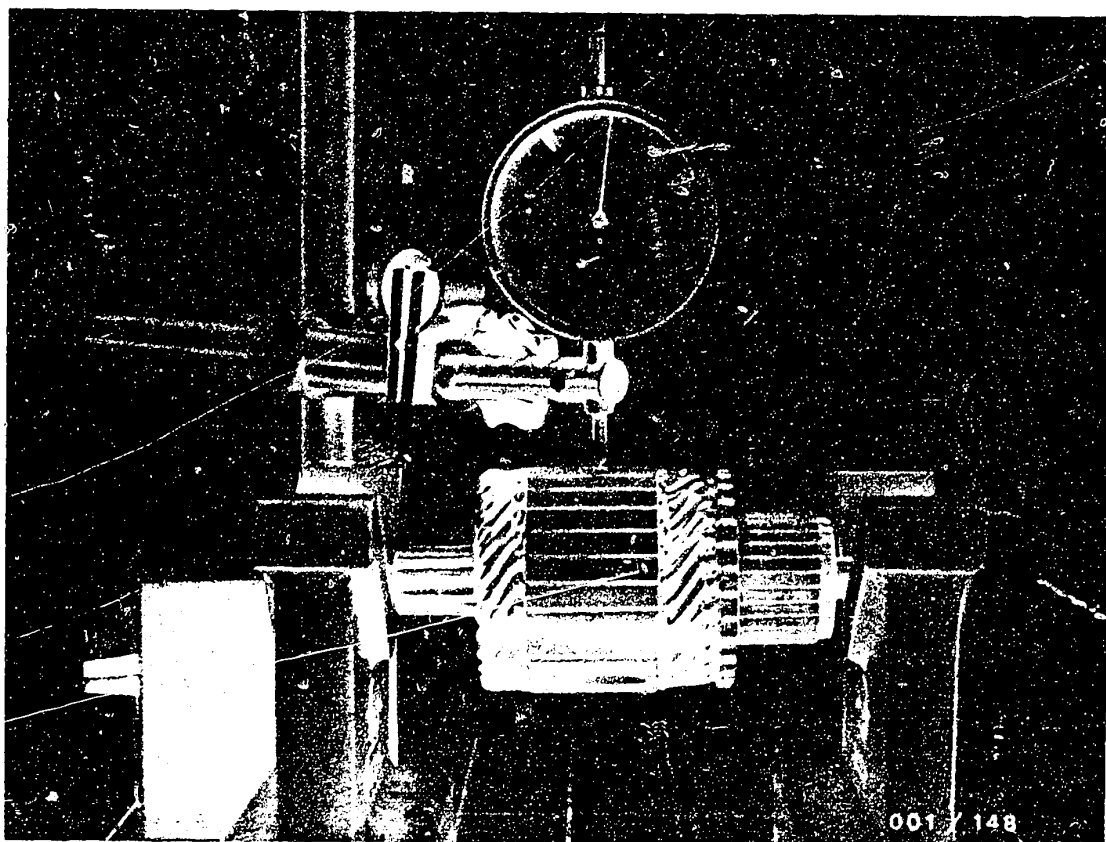
The insulation between the commutator laminations contains asbestos; the dust which is released must be extracted. Health hazard.

#### Finish-turning:

Clamp armature again in lathe and turn down with fine turning tool.

Chips must be no more than 0.03 mm thick.

After finish-turning, brush out the commutator with a clean brush which is free of oil and grease.



Testing the true running of the armature assembly

Commutator	DM starting motors	$\leq 0.02$ mm
	DW starting motors	$\leq 0.01$ mm

Laminated core     $\leq 0.05$  mm

### 10.3 Repairing the drive-bearing housing

Renew the sintered bushing in the drive-end-bearing housing.

#### Repairing the commutator end shield

Renew the sintered bushing in the commutator end shield.

#### Examining the stator frame

Examine the stator frame and permanent magnets for damage (visual examination).

Do not take the permanent magnets out of the stator frame.

If damaged, replace stator frame (permanent magnets are installed).

#### Note:

Under no circumstances may the stator frame be exposed to severe knocks (e.g. number punches) or heavy pressure (e.g. clamping in vice).

#### Examining the drive shaft with ring gear

(only DW starting motors)

Loosen the retainer from planetary-gear drive and remove the ring gear from the drive shaft.

Check the ring gear for cracks and wear.

By means of drive shaft, check bushing in ring gear (play, wear, oval - out-of-ground).

Check bushing in drive shaft (bearing, armature) using plug gauge KDAL 5049 (not-go gauge).

Renew drive shaft with ring gear if damaged or worn.

Re-install ring gear and retainer.

#### Repairing the intermediate bearing (0 001 114 ... only )

Replace sintered bushing in intermediate bearing.





#### 10.4 Overrunning-clutch drive

Unhook fork lever by spreading the fork on overrunning-clutch drive (see picture).

Likewise separate bearing block from fork lever.

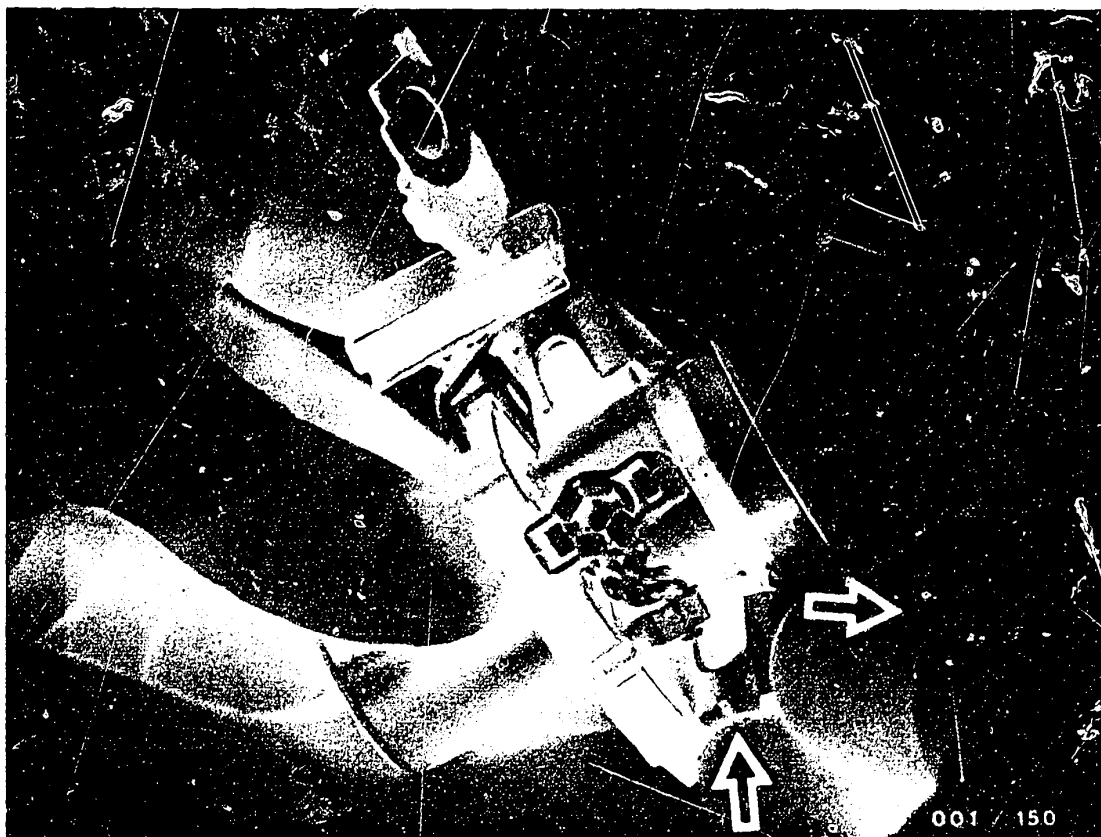
Examine bearing bushings in drive for wear, renewing if necessary.

**B23**

Examination and repair

DM/DW starting motors





### 10.5 Changing the carbon brushes

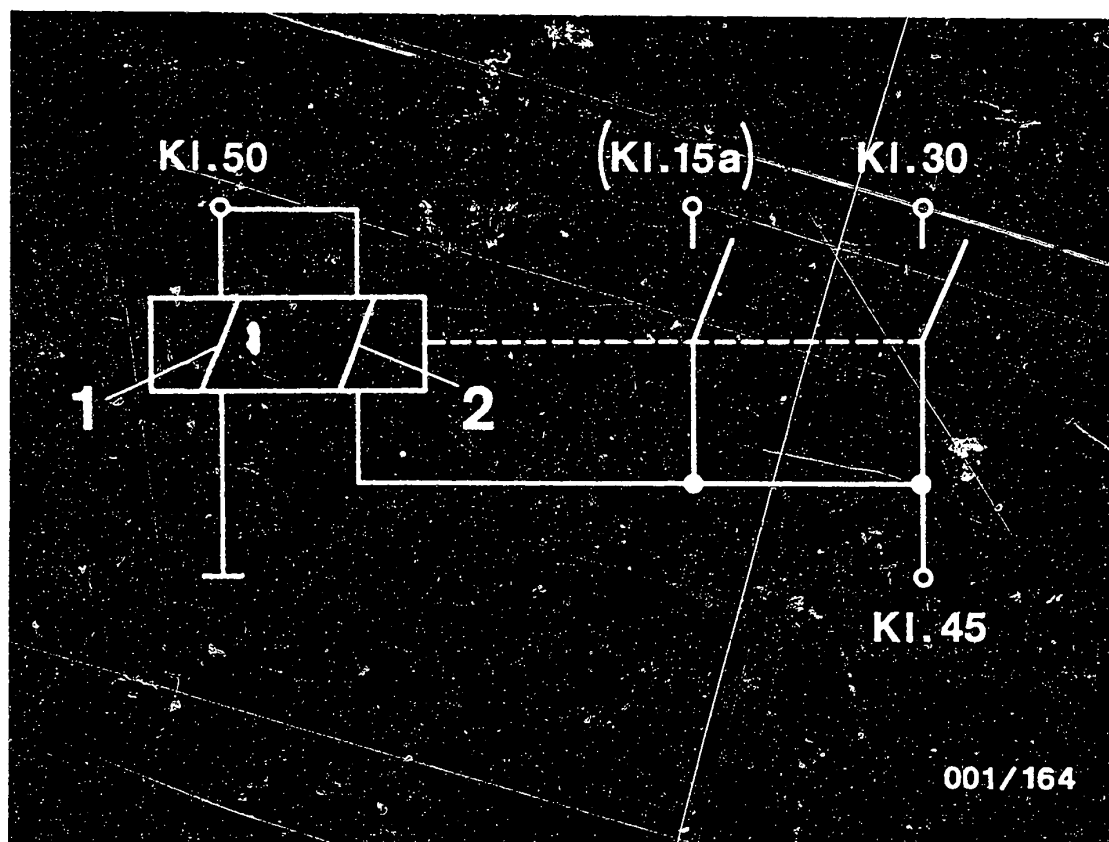
Usable length of carbon brushes: 8 mm

To test the carbon brushes, unhook the brush holders on the brush plate (see picture).

If the carbon brushes are too short or broken renew the entire brush plate.







## 10.6 Examining and repairing the solenoid switch

Solenoid switch: 0 331 303..

Note:

If several solenoid switches are checked at the same time, do not mix up the solenoid armatures and springs.

Electrical test at approx. + 20 °C

Test position: Switch vertical, solenoid armature at top.

Note:

Solenoid armature and return spring are not rigidly connected to the solenoid switch, i.e. the solenoid armature will be flung out when testing. To prevent damage to the solenoid armature during the pull-in test, limit the cut-off movement of the solenoid armature by means of an elastic stop (hard rubber).

## Continuity and insulation test

Set the test panel to 6 V d.c. and test the windings with test prods for continuity.

Test insulated bus bars and windings for short-circuit to ground.

Test voltage for 12 V relay: 40 V a.c.

## Testing the pull-in voltage

Set voltage of approx. 3.5 V on voltage stabilizer or battery with slide resistor or similar.

Connect pull-in winding (2) and holding winding (1) as per top diagram.

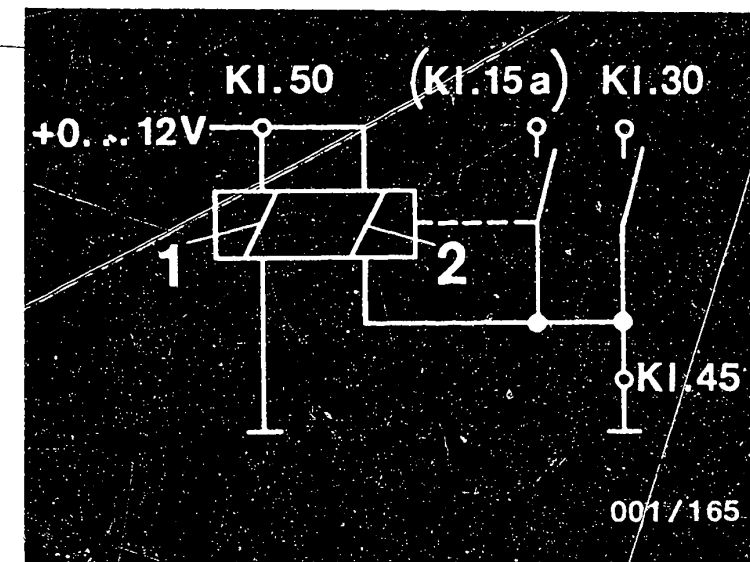
Connect test lamp between + 12 V and term. 30, voltmeter between term. 50 and ground.

Fully press in solenoid armature, allow to spring out again by approx. 8 - 10 mm, and hold in this position (= "solenoid armature clearance").

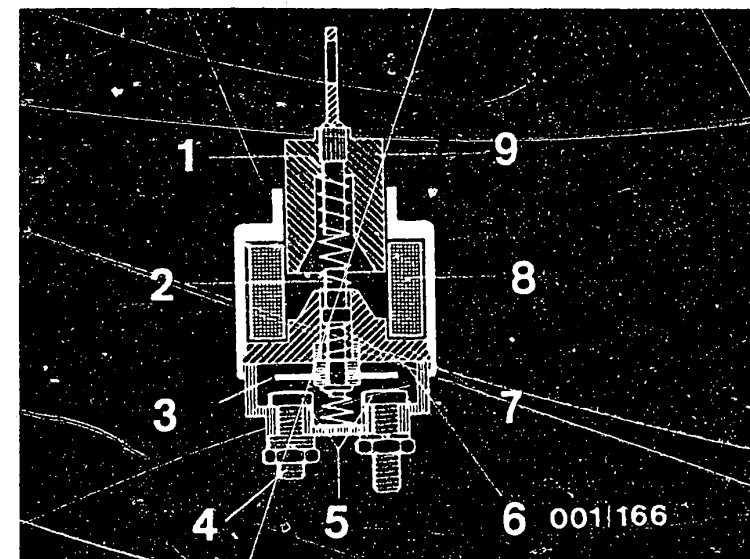
Increase voltage until solenoid armature pulls in, - make reading on voltmeter.

At the same time, test lamp must light up (continuity between contacts 30 and 45). Test duration max. 2 seconds.

Specification for pull-in voltage for: 0 331 303 505 and 0 331 303 563 : 6.0...7.3 V  
0 331 303 553 and 0 331 303 559 : 4.5...6.5 V



- 1 = Holding winding
- 2 = Pull-in winding
- 1 = Return spring
- 2 = Switching pin (split)
- 3 = Bridging contact member
- 4 = Terminal stud (term. 45)
- 5 = Contacts
- 6 = Contact pressure spring
- 7 = Magnetic core
- 8 = Winding
- 9 = Solenoid armature



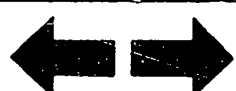
**C2**

Examination and repair  
DM/DW starting motors



**C3**

Examination and repair  
DM/DW starting motors



### Testing the release voltage (only with holding winding)

Disconnect the pull-in winding (2) from ground.

Press in the solenoid armature by hand, and increase the voltage until the solenoid armature is held by the holding winding.

Reduce the voltage until the solenoid armature springs out again.

Release voltage: 0.2 ... 2.0 V

### Testing the burn-off reserve

Pull-in winding (2) disconnected from ground.

Press in solenoid armature (is held only by pull-in winding (1)).

When continuity at the contacts is indicated by the lighting up of the test lamp, it must be possible to move the solenoid armature another approx. 1 mm towards the magnetic core.

### Testing the relay windings for interturn short circuit with double rated voltage (=24 V)

Apply double rated voltage to terminal stud term. 30 and ground of relay housing.

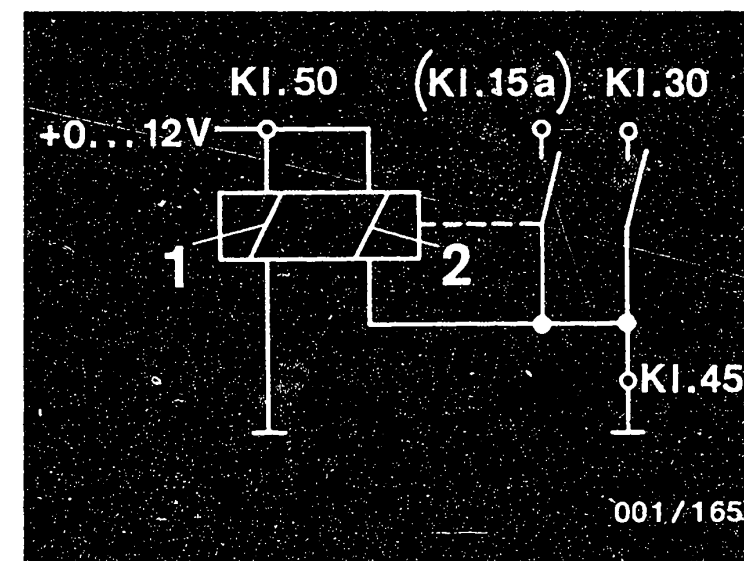
Press in solenoid armature until it rests on magnetic core.

Release solenoid armature.

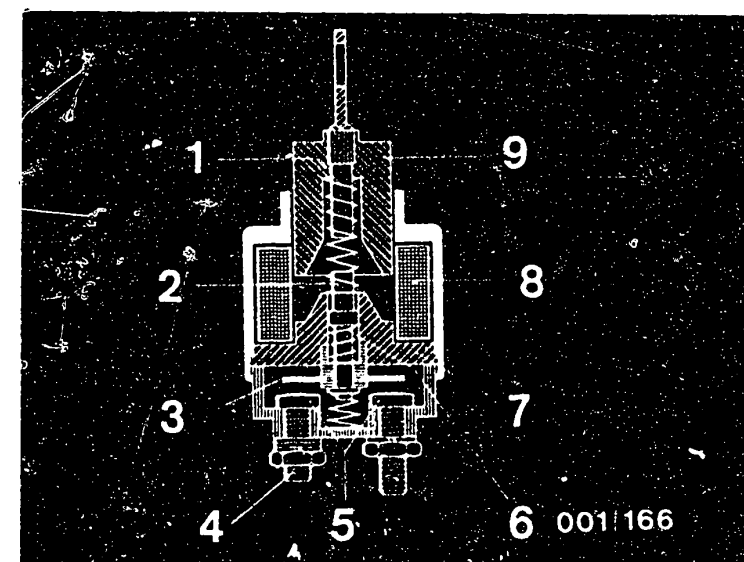
Solenoid armature must automatically jump out due to pressure of return spring. Otherwise, one of the two relay windings has an interturn short circuit.

0 331 303 505 and 0 331 303 559 only:

Using test lamp, test for continuity between term. 15 a and terminal stud term. 45. Press in solenoid armature fully by hand and allow to spring out again. Contacting at solenoid armature clearance 3.2 ... 1.6 mm.



- 1 = Holding winding
- 2 = Pull-in winding
- 1 = Return spring
- 2 = Switching pin (split)
- 3 = Bridging contact member
- 4 = Terminal stud
- 5 = Contacts
- 6 = Contact pressure spring
- 7 = Magnetic core
- 8 = Winding
- 9 = Solenoid armature



**C4**

Examination and repair  
DM/DW starting motors



**C5**

Examination and repair  
DM/DW starting motors



### Mechanical test:

Contact gap from bridging contact member  $3.2 + 1.1 - 0.6$  mm

Burn-off reserve  $1.0 + 0.4 - 0.2$  mm

Preload of contact pressure spring  $24 \pm 5$  Nm

Preload of magnet armature return spring with approx. 9 mm armature clearance  $45.0 \pm 7$  Nm

Preload of return spring for bridging contact member  $12 \pm 3$  Nm

Total force  $129,7 \pm 15$  Nm

### 0 331 303 505 only:

Grease solenoid armature lightly with special lubricating grease 5 932 240 150.

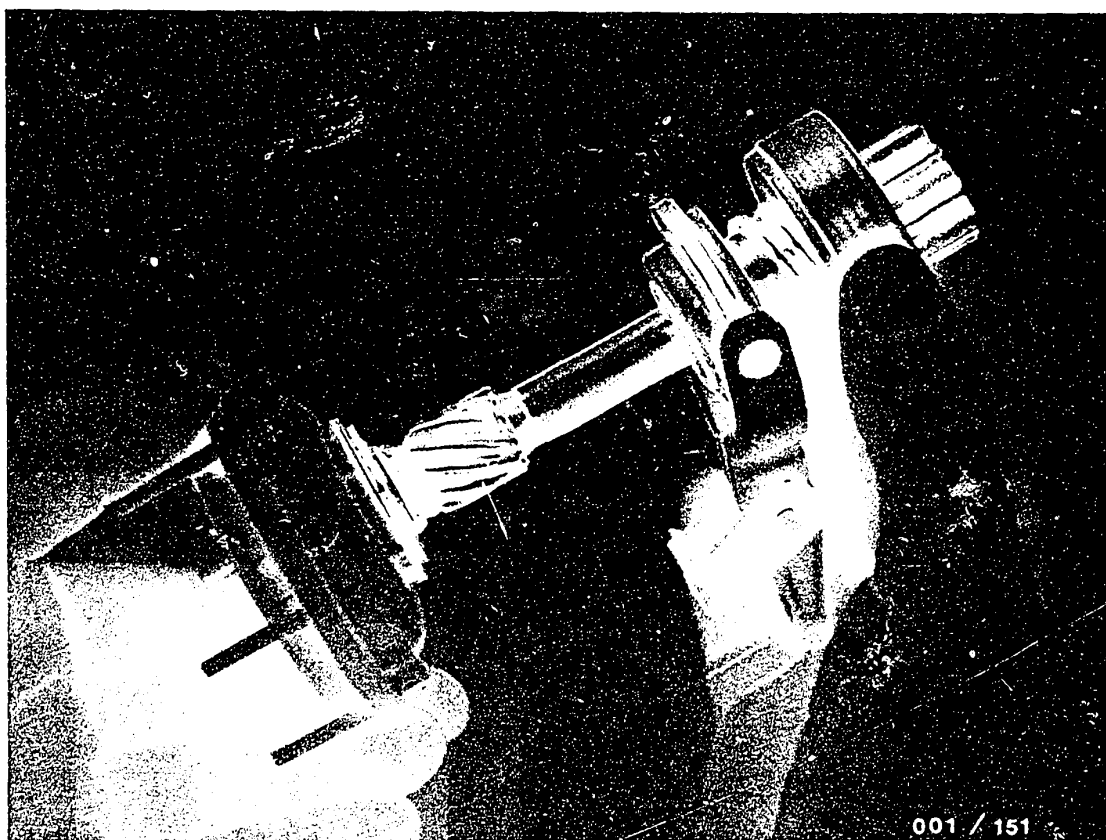
Under no circumstances may grease get onto the end face of the solenoid armature.

If too much grease is applied, the grease is pressed into the switching chamber and there are contact difficulties.

### 0 331 303 553, ... 559, ... 563

Solenoid armatures are coated with lubricating varnish. If the lubricating varnish coating is no longer 100 %, likewise grease solenoid armature lightly with special lubricating grease 5 932 240 150.



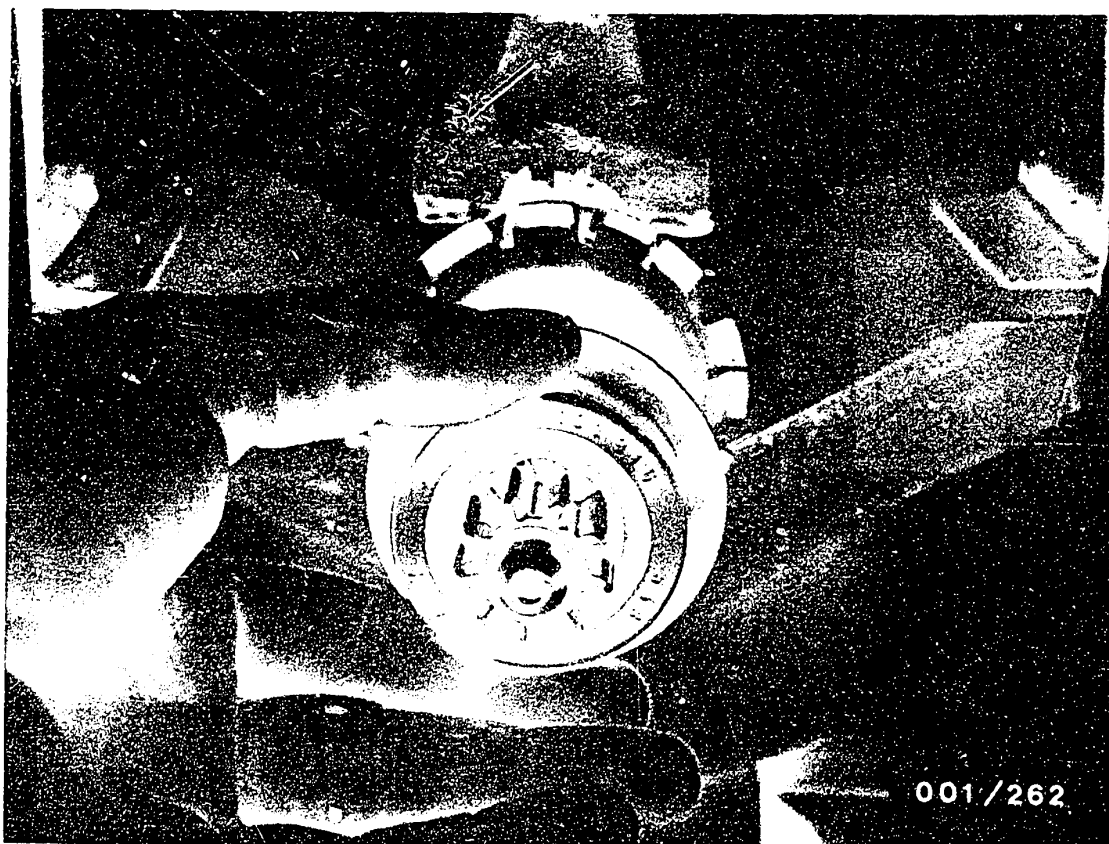


## 11. Assembling the starting motor

### 11.1 Mounting the gear drive with overrunning clutch (DW starting motors)

- Lightly oil pinion bearing surface with oil 5 962 260 000 (VS 13 834).
- Lightly grease spiral spline with special lubricating grease 5 932 240 150.
- Slide overrunning clutch with fork lever and bearing pedestal onto drive shaft (picture).
- Slide stop ring onto armature shaft.
- Using pliers, slightly open up new retainer and insert in armature ring groove.  
Do not scratch armature shaft when doing this.  
Compress retainer in ring groove.

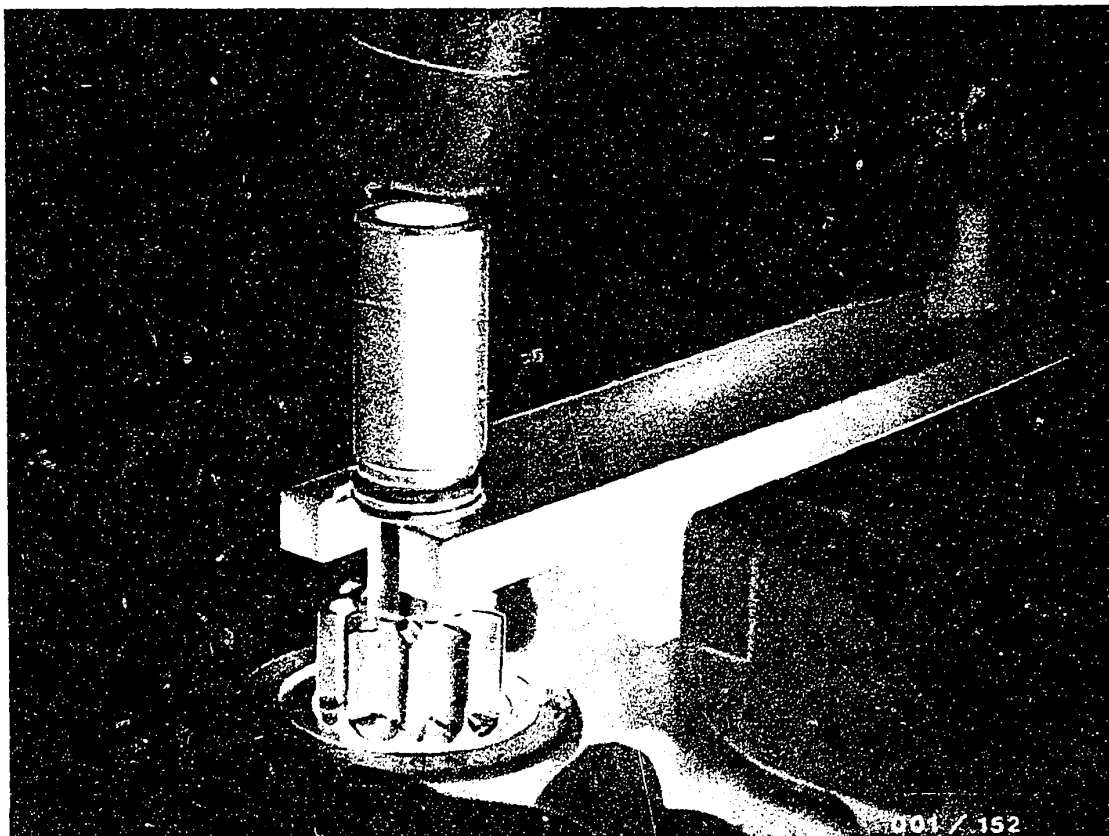




11.1.1 Mounting intermediate bearing, pinion with overrunning clutch on armature shaft (DM starting motors)

- Lightly oil pinion bearing surface with oil 5 962 260 000.
- Grease spiral spline with special lubricating grease 5 700 082 025.
- Lightly oil intermediate bearing with silicone oil 5 962 260 605 and slide intermediate bearing onto armature shaft.
- Slide pinion with overrunning clutch, fork lever and bearing block onto armature shaft.
- Slide stop ring onto armature shaft.
- Using suitable pliers, slightly open new retainer and insert into annular groove of armature. Do not scratch armature shaft when doing this. Press retainer together.

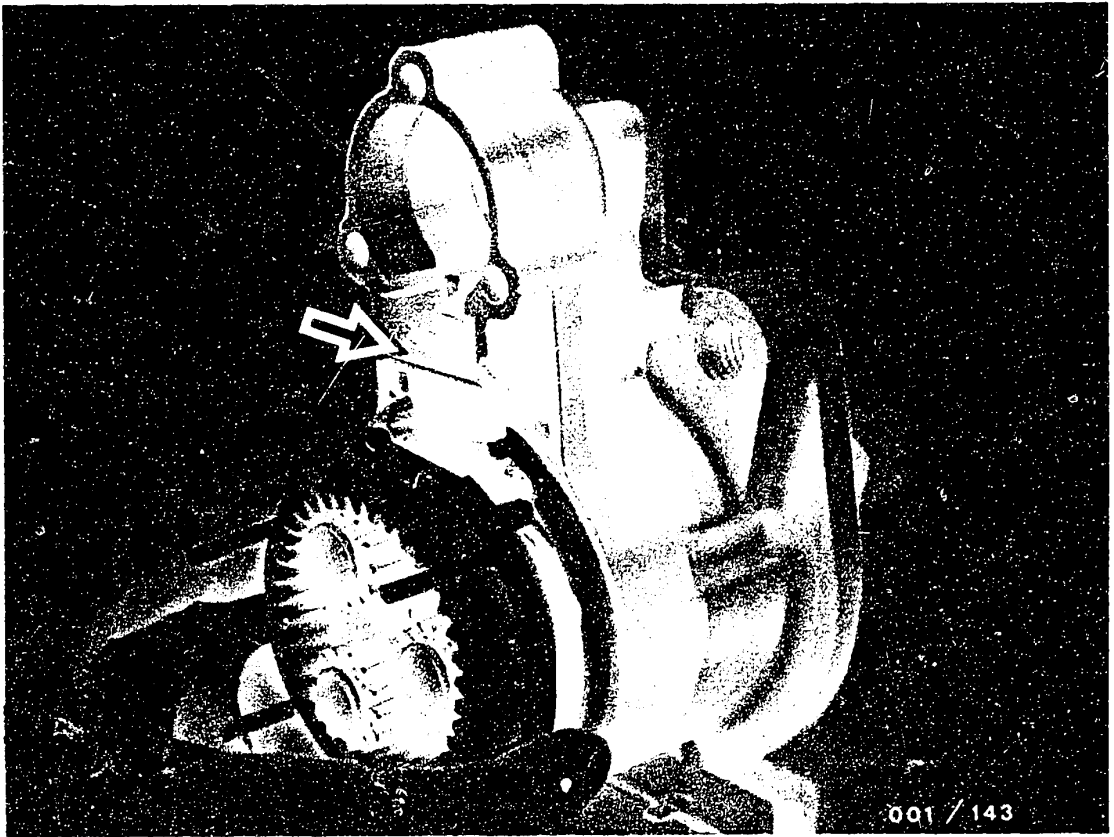




Slide mounting sleeve KDAL 5028 onto armature shaft (turned side of sleeve pointing to retainer) and calk stop ring using KDAL 5487 (picture).

Test the overrunning torque: Should be 0.12...0.18 Nm





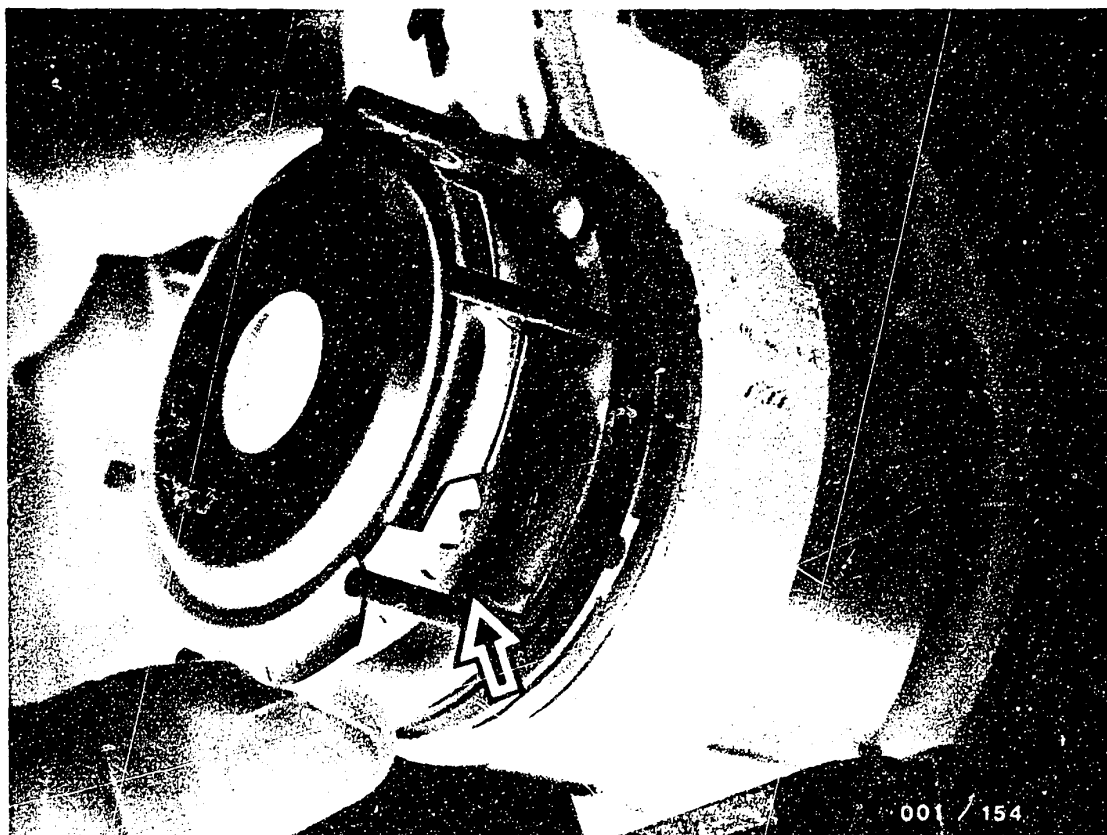
### 11.2 Mounting the drive-end-bearing housing (DW starting motors)

Insert the planetary-gear train with pinion, overrunning clutch, fork lever and bearing pedestal into the drive-end-bearing housing (the bevelled part of the ring gear points toward bearing pedestal/relay, see picture).

Insert rubber seal (counter-bearing for bearing pedestal, arrow).







### Mounting the cover plate (DW starting motors)

Position the cover plate on the ring gear so that the recess on the cover plate is seated in the lug on the ring gear (picture - arrow).



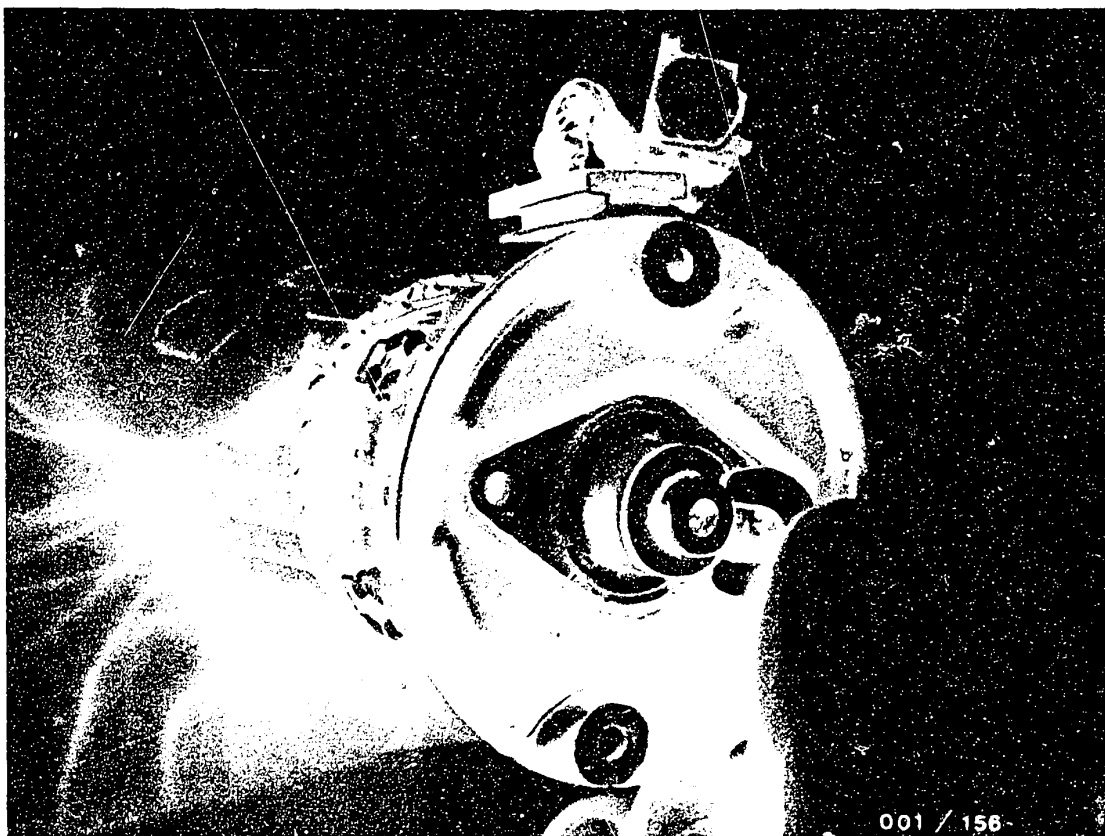


### 11.3 Installing the commutator end shield (DW starting motors)

Position tool KDAL 5048 with brush plate or new brush plate with holding ring on the armature shaft at the commutator end, and slide the brush plate over the commutator (making sure that brush holders are properly seated in anchor point).

- Remove KDAL 5048 or holding ring.
- Lightly oil gasket (felt ring) with oil 5 962 260 000 (VS 13 834) and insert on commutator end (picture - arrow).





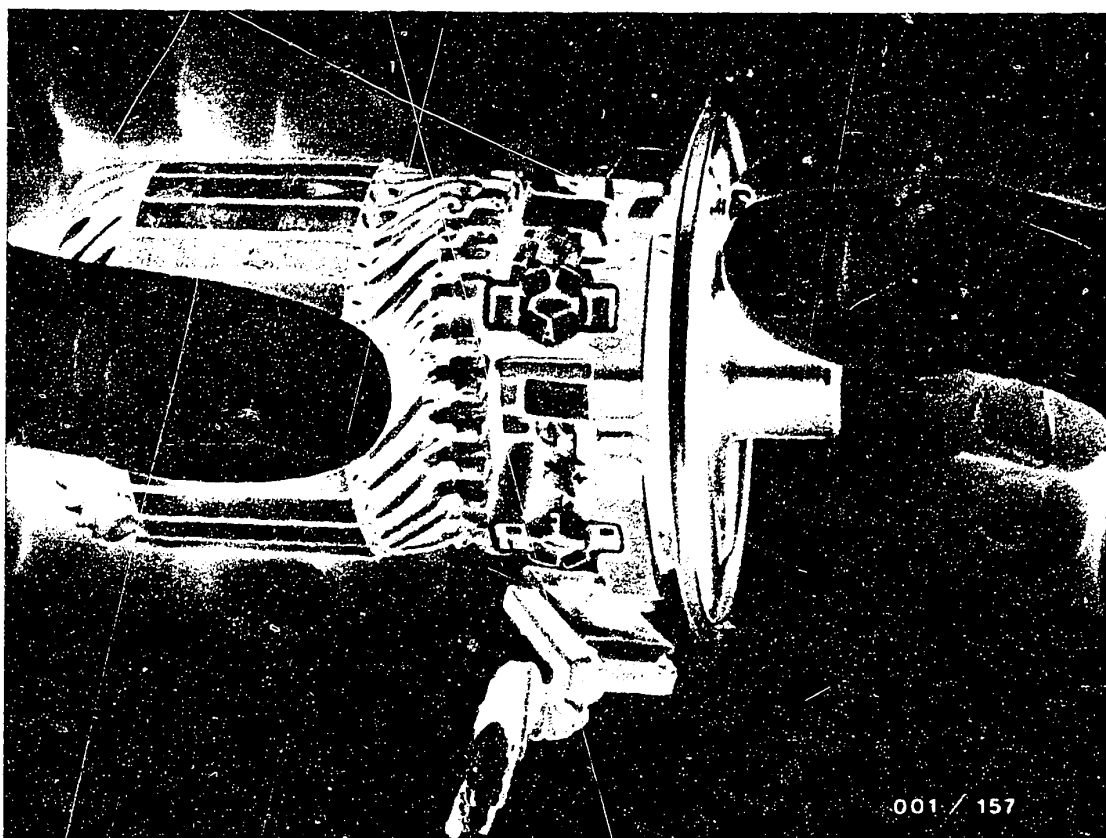
Slide commutator end shield onto armature shaft.

Set armature longitudinal play with 1 washer (shims 1.0 mm, 1.2 mm and 1.4 mm are available).

Insert holding disc (see picture).

Armature longitudinal play: Should be 0.05 ... 0.4 mm



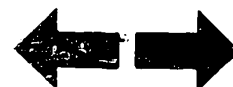


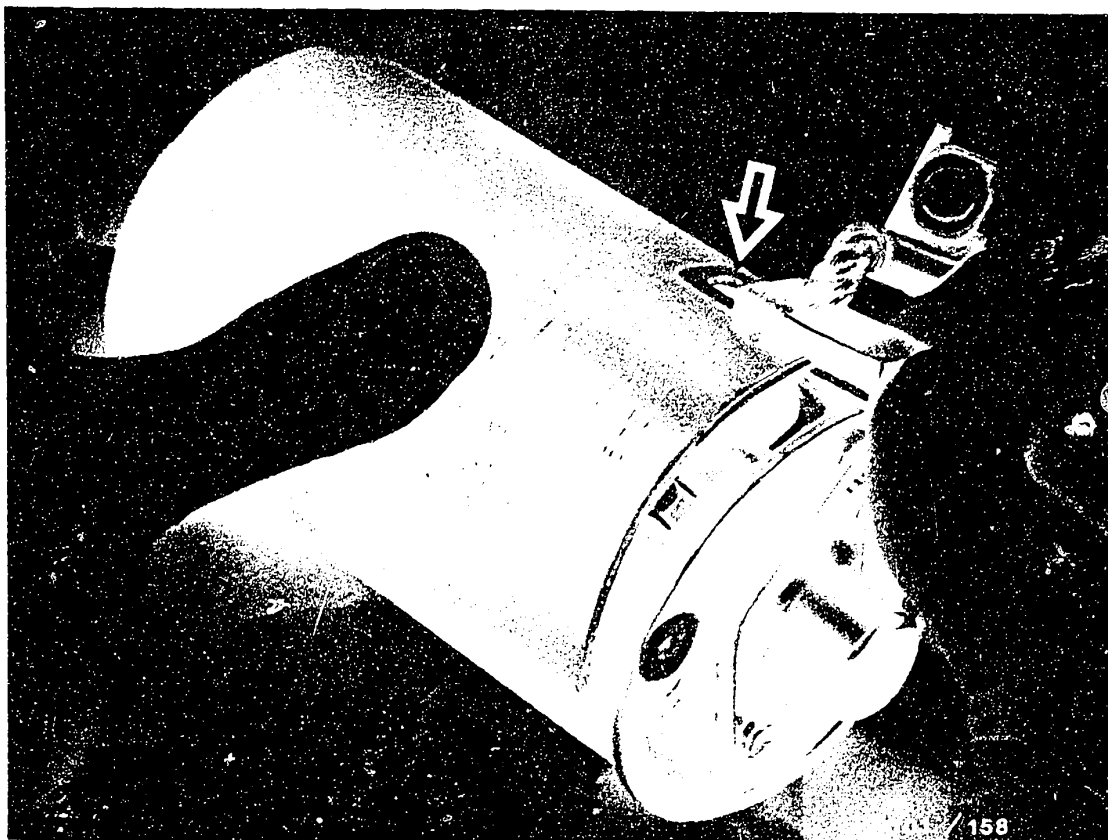
After setting the armature longitudinal play, lightly grease the holding disc and shim with silicone grease 5 700 082 025.

Mount seal and closure cap (screw in screws by hand just enough so that the closure plate is held).

Note:

The armature longitudinal play cannot be adjusted when the starting motor has been assembled.





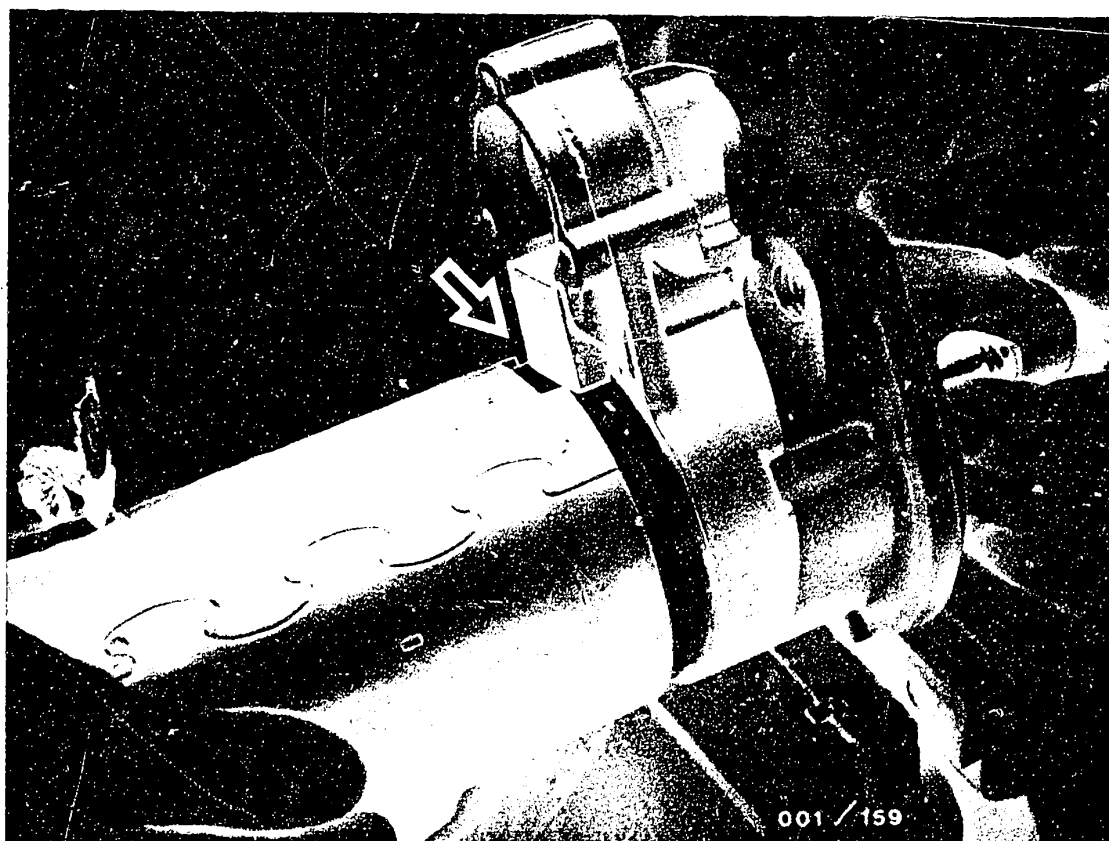
#### 11.4 Assembling the stator frame (DW starting motors)

Slide armature with brush plate and commutator end shield carefully into stator frame.

Fit rubber seal on term. 45 (brush plate) into groove on stator frame (see picture, arrow).

#### Note if using a service-part stator frame

The service-part stator frame is not complete in the designation of the part number of the starting motor (e.g. 0 001 108 ..) because it can be used for more than one starting motor. Under no circumstances may the missing digits be punched into the stator frame since otherwise there will be damage to stator frame and permanent magnet. The last three digits of the part number should be punched onto the side of the drive-end-bearing housing flange when disassembled together with the repair code.



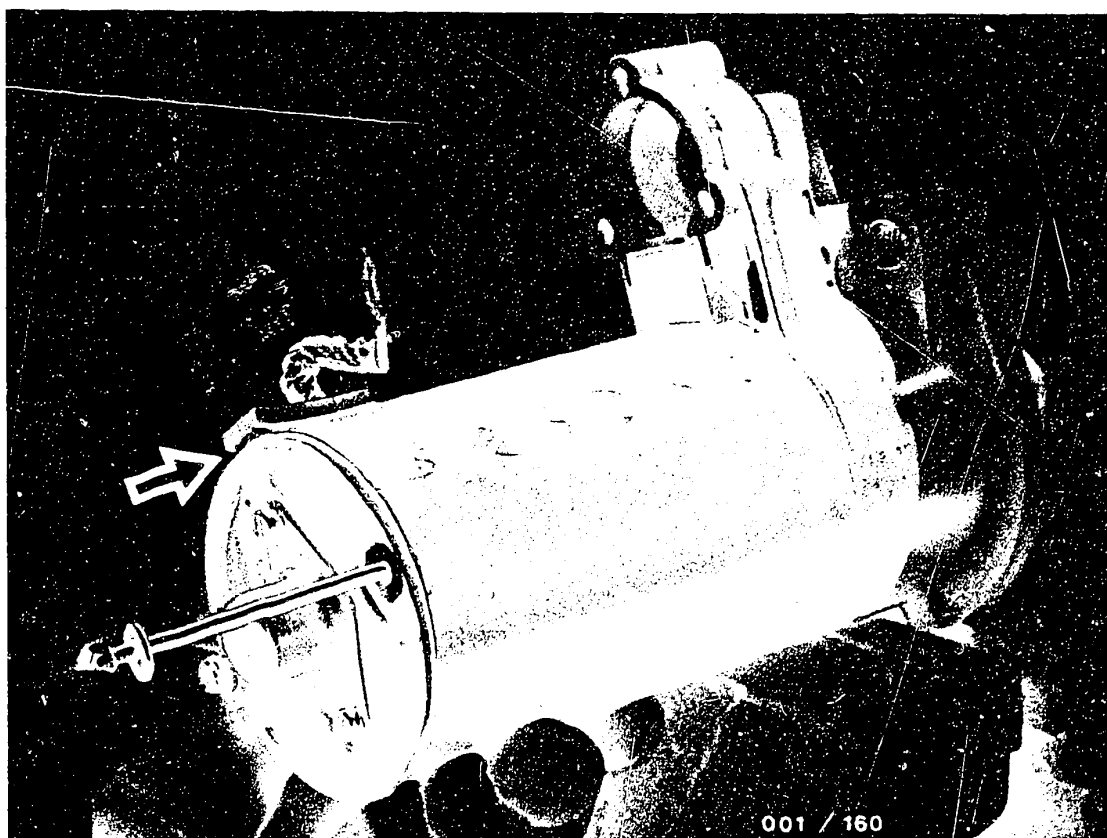
### 11.5 Mounting the stator frame (DW starting motors)

Position the stator frame on the drive-end-bearing housing.

Turn the pinion until the armature latches into the gear wheels; (do not use force).

The groove on the stator frame fits onto the sealing rubber of the bearing pedestal (see picture, arrow).



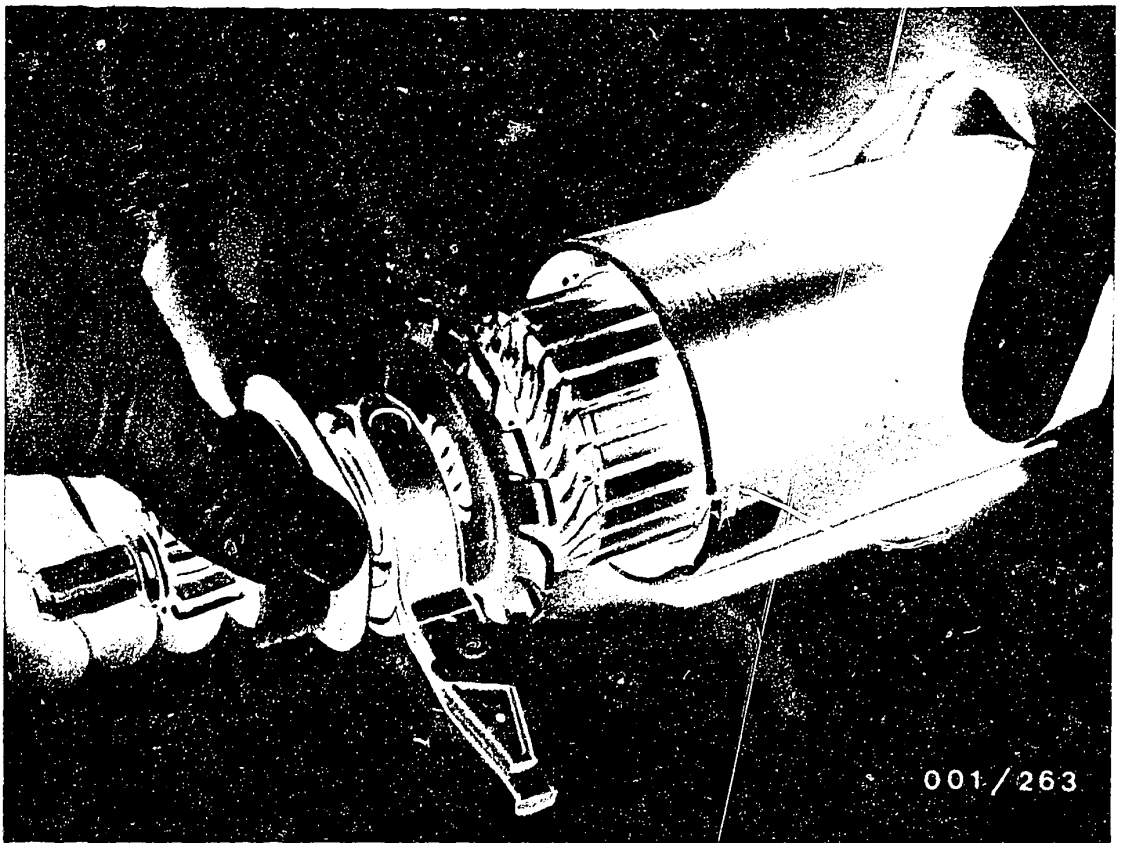


Turn the commutator end shield until the groove on the commutator end shield points to the sealing rubber (picture, arrow).

Position the through bolts and tighten to 4.5 ... 6.0 Nm.

Tighten fastening screws for closure cap to 1.4 ... 2.0 Nm.



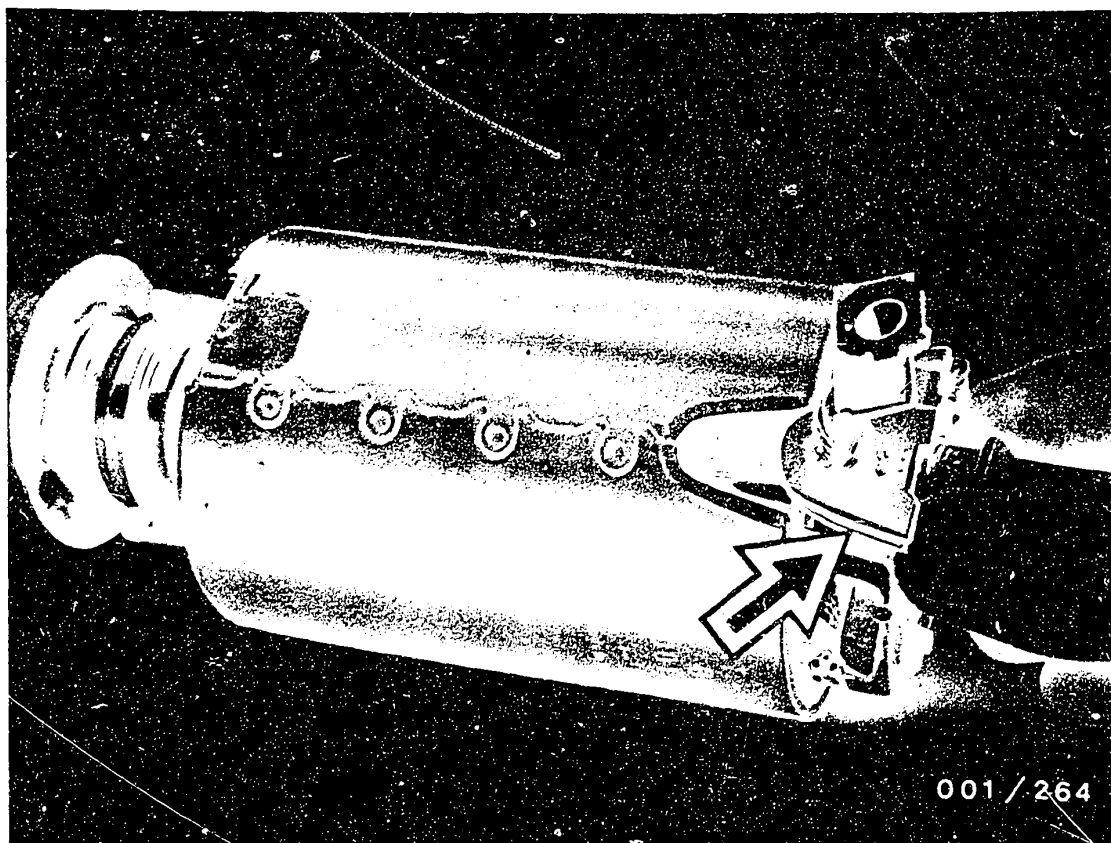


#### 11.5.1 Mounting the stator frame (DM starting motors)

Carefully slide armature with intermediate bearing, pinion with overrunning clutch and fork lever into stator frame (see picture).







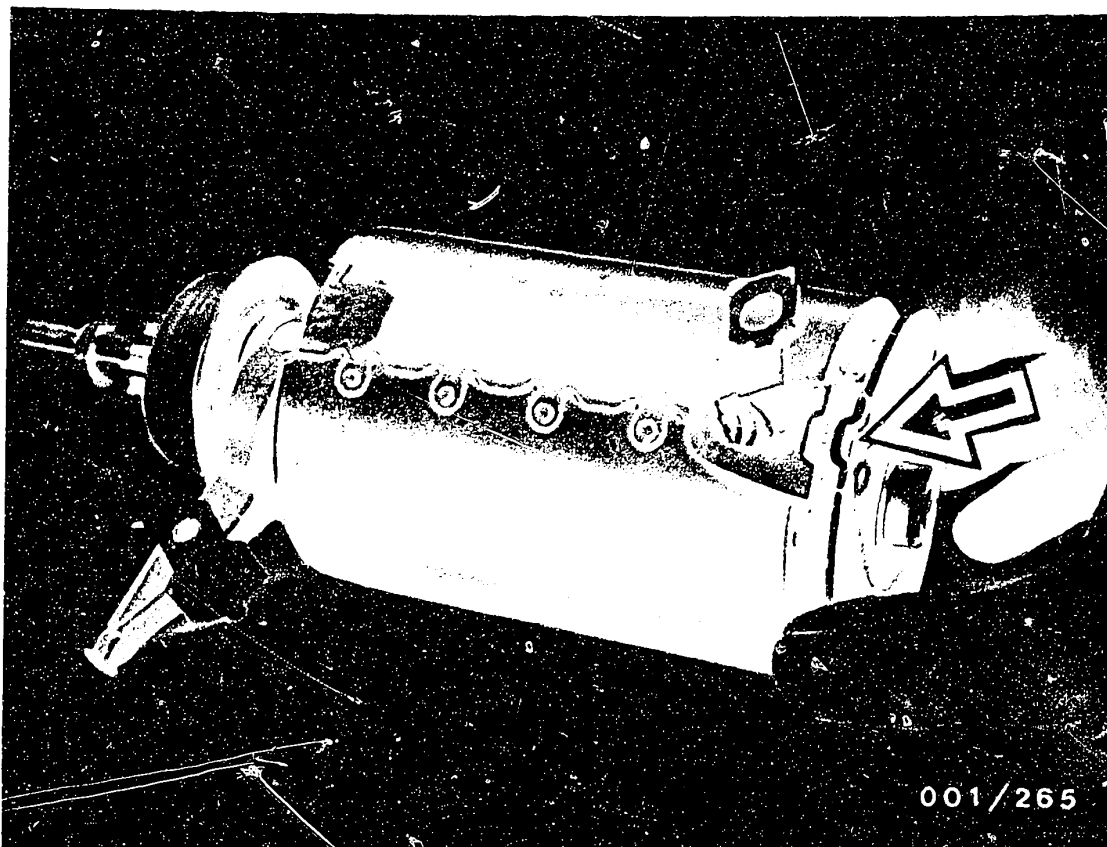
Place assembly tool KDAL 5051 with brush-holder plate on armature shaft. Slide brush-holder plate onto commutator  
Ensure correct seating of rubber leadthrough (picture, arrow).

**C19**

Assembling the starting motor

DM/DW starting motors



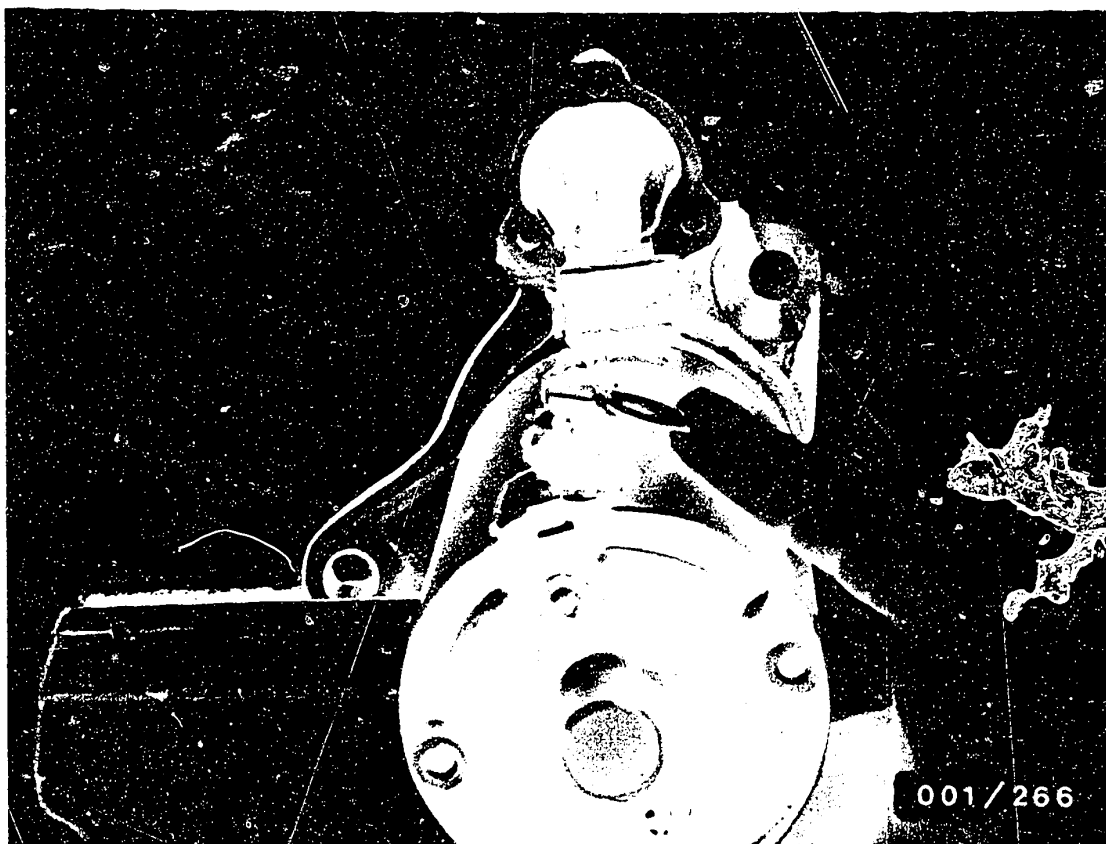


Slide commutator end shield onto armature shaft.  
Ensure that commutator end shield (picture, arrow)  
locates.

Put on shim and holding washer and adjust armature  
longitudinal play.

Armature longitudinal play should be: 0.05 ... 0.4 mm

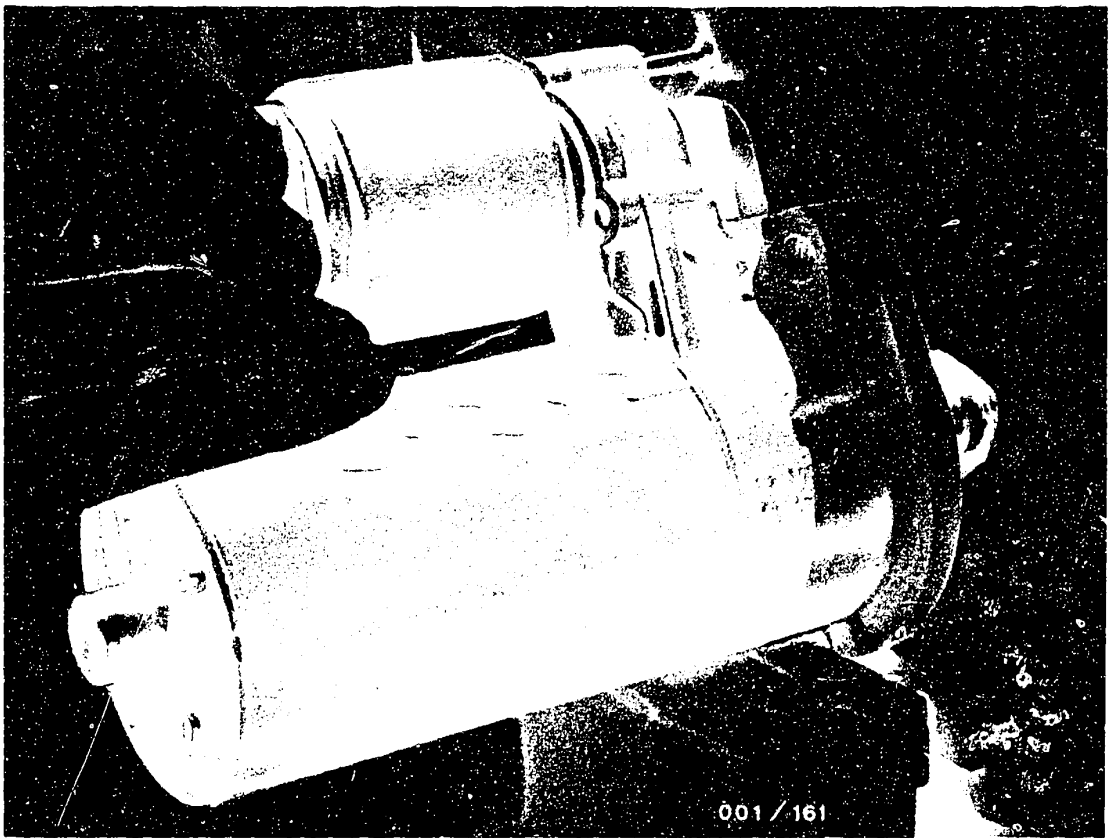




Clamp drive-end-bearing housing by eye.  
Insert stator frame with armature into drive-end-  
bearing housing (picture).

Position through-bolts and tighten to 4.5 ... 6.0 Nm.

Put on protective cap and tighten fastening screws to  
1.4 ... 2.0 Nm.



### 11.6 Mounting the solenoid switch

Hook the solenoid switch armature into the fork lever.

Insert solenoid armature return spring and screw down solenoid switch housing.

Tightening torque for 3 fastening screws:  
4.5 ... 6.3

Mount term. 45 on relay.

Tighten nut to 7 ... 9 Nm.

Test the armature braking torque:

Should be (DW starting motors) 0.9 ... 1,4 Nm

Should be (DM starting motors) 0.3 ... 0,4 Nm



## 12. Testing on the test bench

### 12.1 General

The following test benches can be used:

EFAL 140 in conjunction with 10 m  $\Omega$  series resistor

EFAL 152 connection term. 30/2 (with series resistor)

EFAL 153

Clamp the starting motor properly on the test bench.  
Do not mix up connections (+ to term. 30, - (ground) to housing)!!!

Connect positive and negative cables from test bench to starting motor. Tighten electrical connections (terminal studs) properly.

The electrical test specifications depend on the condition of the battery (capacity and state of charge) and the test duration (temperature of starting motor, state of discharge of battery). The test specifications apply only to the test bench and cannot be applied to starting motors which have been installed on the engine or in the vehicle. A small starting motor is more heavily loaded by the battery installed in the test bench, whereas the capacity of the test bench battery is not sufficient in the case of large starting motors to obtain the maximum output. The inevitably longer leads in the test bench also influence the output of the starting motor. Therefore, the test duration should be as short as possible and the battery should be in good condition and at least three quarters charged.

In the case of defective starting motors the measured values differ considerably from the test specifications given. In this case, dismantle the starting motor again and repeat the tests on the individual components.

Note: Crankshaft-mounted starting motors must be supported with a suitable flanged bearing when testing.



## 12.2 Testing on the test bench

### Note:

Do not mix up terminals!

+ from test bench to solenoid switch term. 30

- from test bench to starting-motor housing

### Testing of solenoid switch with tooth/tooth connection on test bench EFAL 152/153:

Clamp starting motor so that pinion can be pushed forward max. 2 mm.

Minimum voltage at which solenoid switch must pull in with tooth/tooth connection:

0 331 302 505, .. 563  $\leq$  8 V

0 331 302 553, .. 559  $\leq$  7.3 V

### Testing of solenoid switch with tooth/tooth connection on other test benches:

Clamp starting motor so that pinion can be pushed forward max. 2 mm.

During testing, + from test bench must not be connected to term. 30 on starting motor.

Using voltage stabilizer (12 V approx. 25 A) or 12 V battery with sliding resistor or similar, raise voltage until solenoid switch pulls in.

0 331 302 505, .. 563  $\leq$  8 V

0 331 302 553, .. 559  $\leq$  7.3 V



### 12.3 No-load and short-circuit test

The test specifications are based on two 12 V/143 Ah batteries 3/4 charged with a 10 m  $\Omega$  resistor connected in series; or one 12 V/143 Ah battery with 10 m  $\Omega$  resistor in series.

#### No-load values

0 001 108 ..	with 11.5 V,	< 75 A	> 2900 min <sup>-1</sup>	
110 ..	with 11.2 V,	< 95 A	> 2800 min <sup>-1</sup>	
			( > 2500 min <sup>-1</sup> )	1)
111 ..	with 23 V,	< 40 A	> 2800 min <sup>-1</sup>	
0 001 112 ..	with 11.5 V,	< 45 A	> 5500 min <sup>-1</sup>	
0 001 113 ..	with 11.5 V,	< 45 A	> 5000 min <sup>-1</sup>	
0 001 114 ..	with 11.4 V,	< 50 A	> 5000 min <sup>-1</sup>	

#### Short-circuit test

For the short-circuit test, ring gear/gear segment of the test bench and of the starting-motor pinion must have the same module (toothing); otherwise, exchange ring gear of test bench or set different gear segment (for module and number of teeth of starting-motor pinion, see specifications on motor-vehicle electrics).

Note: 12 V starting motors with permanent excitation must not be operated on 24 V.

Armature will be rotated at overspeed.

Stator frame might crack open and parts of armature might be flung out.

1) Starting motor with transmission ratio  $i = 3.33$



### 12.3.1 Backlash

The backlash is the gap (play) between the tooth flanks of the meshed pinion and of the ring gear/tooth segment.

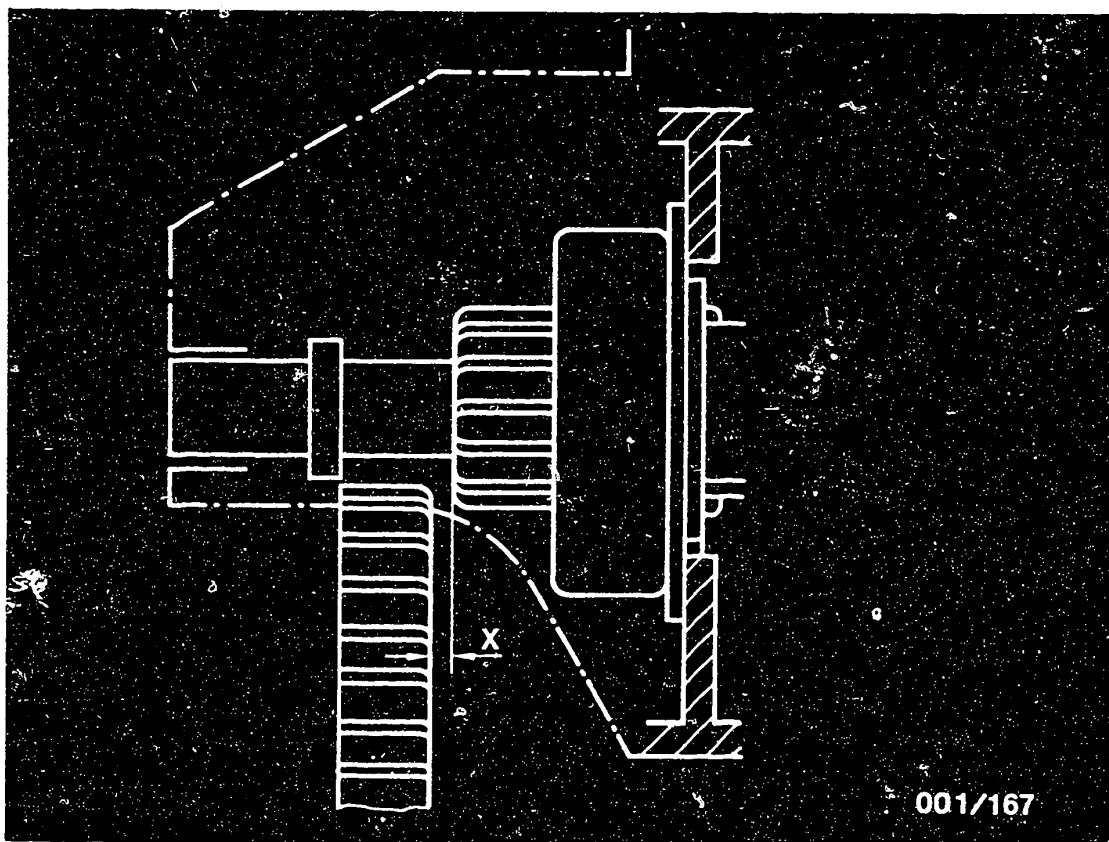
For measuring, mesh pinion by hand and hold, or slide starting motor forward, check backlash with feeler gauge. (Not possible with starting motor installed in vehicle).

Too little or too much play causes heavy wear at the teeth and can even lead to the breaking off of entire teeth.

Backlash                      Should be 0.3 ... 0.6 mm







001/167

### 12.3.2 Pinion clearance

The pinion clearance is the distance between the ring gear and the end face of the pinion with the starting motor in the rest position.

If the clearance is too great, the pinion does not mesh far enough into the ring gear; pinion teeth and ring-gear teeth have insufficient contact area and are consequently exposed to severe one-sided loading.

The minimum clearance is necessary so that the pinion safely demeshes, does not strike against the rotating ring gear in the case of heavy vibrations and also so that it cannot mesh so far that the pinion drive spindle comes up against the ring gear.

Pinion clearance

Should be 2.0 ... 3.0 mm

**D5**

Testing and test bench

DM/DW starting motors



### 12.3.3 Test procedure for short-circuit test

Set the starting motor voltage on the test bench by means of the measuring-range selector switch.

In the case of test benches with gear wheel/ring gear, switch on the starting motor and brake to a stop. Make readings. Perform test only briefly, max. 1 to 2 seconds.

In the case of test benches with a fixed tooth segment, briefly switch on the starting motor, make readings.

The following table gives short-circuit test specifications.

**D6**

Testing and test bench

DM/DW starting motors



Part no.	Testing with 2 x 143 Ah batteries in parallel and 10 m $\Omega$ resistor in series			Testing with 1 x 143 Ah battery and 10 m $\Omega$ resistor in series			Testing with 2 x 143 Ah battery in series and 10 m $\Omega$ resistor in series		
	V	A	Torque (Nm)	V	A	Torque (Nm)	V	A	Torque (Nm)
0 001 108 ..	3.5	475 - 600	> 12.5	3.2	430 - 550	> 11.5			
	4.5	625 - 800	> 16	4.2	580 - 750	> 15			
0 001 110 ..	3.8	650 - 840	> 17.5 ( >15.0) <sup>1)</sup>	3.5	600 - 790	> 17 ( > 14.5) <sup>1)</sup>			
	3.0	510 - 660	> 14 ( >11.5) <sup>1)</sup>	2.7	460 - 610	> 13.5 ( > 11.0) <sup>1)</sup>			
0 001 111 ..							12	450 - 550	> 25.0
							14	550 - 650	> 28.0
0 001 112 ..				5.7	350 - 450	> 7.0			
				6.7	400 - 500	> 8.0			
0 001 113 ..				5.7	350 - 450	> 6.0			
				6.7	400 - 500	> 7.0			
0 001 114 ..				5.2	400 - 500	> 7.5			
				6.2	450 - 550	> 8.5			

If test specifications are obtained, starting motor is O.K.

1) Starting motor with transmission ratio  $i = 3.33$

**D7**

Testing on test bench  
DM/DW starting motors



**D8**

Testing on test bench  
DM/DW starting motors



# After-sales Service

## Technical Bulletin

Only for use within the Bosch organization. Not to be communicated to any third party.

### Parts Cleaning

Use of highly-inflammable cleaning agents, or cleaning agents which are dangerous to health

**Gen.**

VDT-I-Gen./18 En  
7.1978

When cleaning parts which come from vehicle electrical products prior to repair, it is permitted to use the following cleaning agents: Benzine, trichloethylene (tri) and perchloroethylene (per). These are dangerous, and must be handled with appropriate care. The relevant safety regulations in West Germany are:

Regulations concerning work with inflammable liquids (VbF) issued by the Federal Labor Ministry (BmA).

Safety regulations for the use of chlorinated hydrocarbons  
as applied to the works ZH1/222  
as applied to personnel ZH1/119

as issued by the Federation of the Trade co-operative Associations  
(Central Association for Accident Prevention and Industrial Medicine)  
Langartweg 103, D-5300 Bonn 5).

1. Benzine, acetone and ethanol (ethyl alcohol) are inflammable liquids and their mixtures with air are dangerous due to the risk of explosion. Parts washing may only take place in tanks or containers solely intended for this purpose and equipped with a "melt" safety device for the lid which, in case the liquid catches fire, causes the lid to close automatically and smother the fire. In the case of larger containers (exceeding 500 x 500mm) some form of suction extraction must be provided.
- 1.1 Generators, alternators, wiper motors, small-power motors and other electrical equipment for installation in vehicles are, in ever increasing numbers, being equipped with capacitors having long storage times (e.g. for interference-suppression purposes in radio-receiver or transmitter installations).

When washing such parts, it is possible that a capacitor discharge can occur when the part is immersed in the cleaning agent. This can lead to an inflammable liquid catching fire. For this reason, parts on which a capacitor is fitted are only to be washed in trichloethylene (tri) or perchloroethylene (per).

- 1.2 In the case of starting motors, it has already been pointed out in earlier repair instructions that the parts should be thoroughly dried after washing in benzine, this applies particularly to windings. With sliding-gear starting motors, the first test run after washing out must be performed without the closure cap in order to avoid the possibility of explosion.

**BOSCH**

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Imprimé en République Fédérale d'Allemagne par Robert Bosch GmbH

**N1**

Technical Bulletin

DM/DW starting motors



2. Trichlorethylene (tri) and perchloroethylene (per) are both liquids whose vapors have a stupefying effect, and which are dangerous to health if inhaled over long periods. Tri vapor is heavier than air, and therefore especially dangerous at floor level. Gloves and goggles are to be worn when washing out parts in these liquids.

If cleaning of parts is carried out regularly, or continuously, in trichlorethylene only containers or tanks intended solely for this purpose are to be used, and the suction extraction device is to be switched on. When washing parts do not bend over the container.



# After-sales Service

## Technical Bulletin

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HEALTH HAZARD DUE TO ASBESTOS DUST

VDI-I-Gen. 043 En

Note on repair

12.1981

Extractor for undercutting (commuta-  
tor) saw

supersedes edition of 11.1981

Working on asbestos or products containing asbestos results in the generation of dust and minute fibers which can in the long term lead to serious damage to health.

The European Community passed a law on 28 March 1981 restricting the use of asbestos and providing for new safety regulations with regard to working with materials containing asbestos.

### Note on the repair of starting motors, generators and motors

The insulation between the commutator segments of the armatures of starting motors, generators and motors still has a high asbestos content.

It is absolutely essential to extract the asbestos dust generated when undercutting this insulation with undercutting saw KDAW 9998.

As laid down in new VDI guidelines, the asbestos dust must only be extracted with an approved dirt extractor.

We therefore recommend the dirt extractor WAP-turbo M-I S-FA with the seal of approval of the German employers' liability insurance association, obtainable from

Firma Guido Oberdorfer  
WAP-Maschinen  
D-7919 Bellenberg  
Tel. 07306/5055

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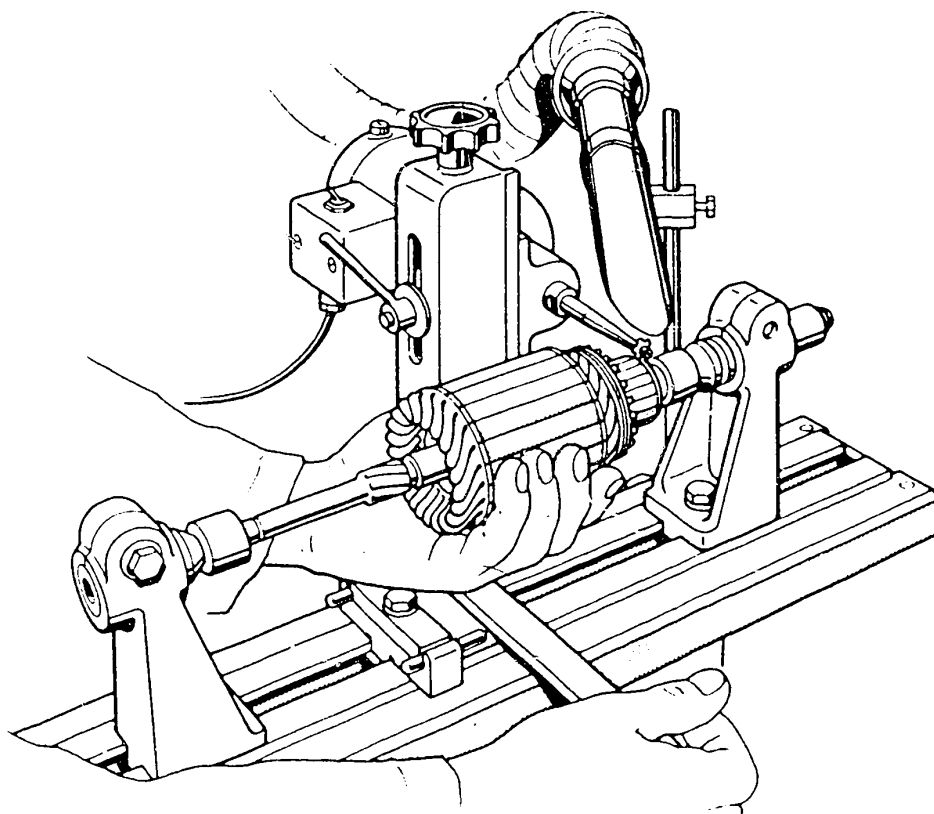
**N3**

Technical Bulletin

DM/DW starting motors



As an accessory for the extractor we offer the stand KDAW 9998/20 which can be used for securing the suction tube with nozzle (see sketch).



Please direct questions and comments concerning the contents to our authorized representative in your country.



# After-sales Service

## Technical Bulletin

Only for use within the Bosch organization. Not to be communicated to any third party.

INTERMEDIATE-TRANSMISSION STARTING MOTOR WITH  
EPICYCLOIDAL GEAR TRAIN AND PERMANENT-MAGNET  
EXCITATION.

VDT-I-001/131 En  
4.1982

0 001 108 .. DW 12 V 1.1 kW

The newly developed type of starting motor with epicycloidal intermediate transmission and permanent-magnet excitation is being introduced as original equipment in 1982 (see Technical Bulletin "New product" VDT-I-001/1 for information on the starting motor).

First application: AUDI 100 2.2 l, 5-cyl. engine  
AUDI 200

It should be noted that in comparison with the previous starting motor, the DW starting motor is, because of its construction, sensitive to impact, shock and pressure and may only be clamped by its flange when testing.

Until further notice, please send in all complaint starting motors of the new type unopened together with the usual warranty documents and stating the reason for the complaint.

From inside Germany to:

ROBERT BOSCH GMBH  
Abteilung K9/VAK 2  
Robert Bosch-Straße  
7141 Schwieberdingen

From outside Germany through RG/AV to:

ROBERT BOSCH GMBH  
Abteilung KH/LAV  
Auf der Breit 4  
D 7500 Karlsruhe 41  
zur Weiterleitung an K9/VAK 2

The intermediate-transmission starting motor (Part No.: 0 001 108 001/..002) can - insofar as it is not in stock - be replaced by the after-sales service by the previous starting motor version 0 001 311 140.

In case of inquiries, please contact your local representative.

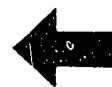
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**N5**

Technical Bulletin

DM/DW starting motors





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